PETROLEUM
REFINER
SEPTEMBER, 1950
SPECIALIZED FOR REFINING, NATURAL GASOLINE, AND PETRO-CHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

IF IT'S TUBE CLEANING...
...IT'S LAGONDA!

. . . same as it has been since the first tube still was built. Lagonda cleaners showed the way then, and they're still doing it . . . If you don't know how well they work, a tryout could be mighty interesting. Tell us when.

ELLIOTT COMPANY
LAGONDA DIVISION • SPRINGFIELD, OHIO
DISTRICT OFFICES IN PRINCIPAL CITIES

WHY WORK *Blind*

WHEN YOU CAN KNOW THE FACTS?

%Proportioneers% Continuous Automatic Blender by
showing component totals
provides new flexibility, accuracy and economy in
handling base stocks and
additives.

%Proportioneers% Continuous. Automatic Blender at Standard Oil Company of Ohio at Cleveland. This installation blends four base stocks and any four out of nine additives. Note lights indicating panels in operation.

1 **Blender operation** is controlled from a single drum switch on master panel with "test" position during which individual components are recirculated within the machine and *totalizers show* whether component settings are correct.

2 **Production capacity** is controlled from master panel and can be altered within a 1 to 3 range without affecting the pre-set percentages of base stocks and additives.

3 **"Band Spread" feature** permits setting additive proportions to within .01% of batch. Viscosity of finished product will be within ± 2SSU if incoming base stocks are uniform. Infinite flexibility in setting component percentages, with same degree of precision in setting percentage of a small component as of a large component.

4 **Electrical interlocks protect quality of finished product:** Upon failure of any component to reach the machine, all panels will automatically return to "recirculation", cutting off blend manifold. Any shortage is automatically made up so finished product will be on specification at end of run.

5 **Tally meter** throws blender back on "recirculation" after adjustably pre-set batch of finished product is completed.

6 **Warning lights** show panel in use and designate *which* component has failed and *why*.

7 **Automatic blow-back feature** to clear any line or lines is built into each panel.

8 **Mixers** with or without dehydration feature are optional.

9 **All wiring is in explosion-proof conduit** for class 1, Group D hazardous locations.

10 **Construction is unitized:** all base stock and additive panels are of uniform design and can be assembled in any grouping; extra panels can be provided at any time for additional components or increased plant capacity.

Write for recommendations or Brochure SM2055.

% PROPORTIONEERS, INC. %

Write to %Proportioneers, Inc.%, 412 Harris Ave., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

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PETROLEUM REFINER and The REFINERY CATALOG
for the refining-natural gasoline industry

WORLD OIL (formerly The Oil Weekly)
and The COMPOSITE CATALOG
for the drilling-producing-pipe line industry

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Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President A. L. BURNS, General Manager

VOLUME 29, No. 9 SEPTEMBER, 1950

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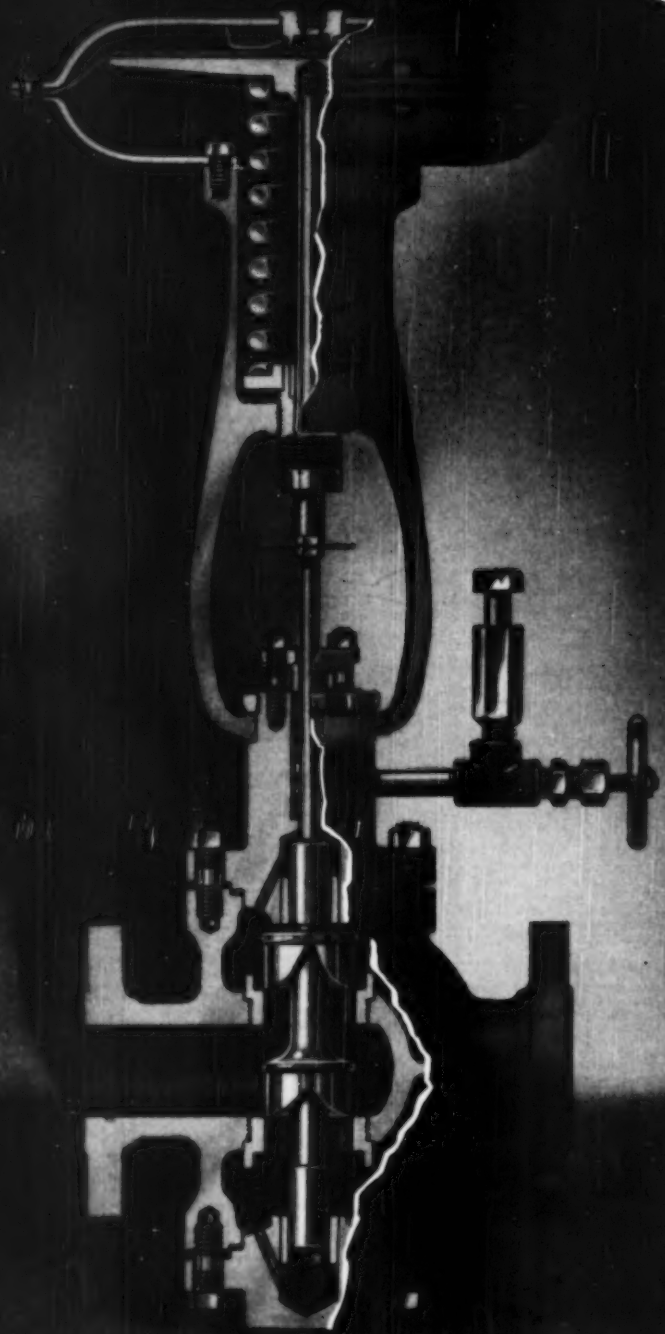

Combines Practical Features

MASONEILAN
Air Operated
CONTROL VALVES
...Insure Better Performance

Incorporated in the new Masoneilan control valves are many practical features that provide users with better-than-ever control.

Highly Responsive

- Design insures minimum of hysteresis.
- Large effective area, moulded diaphragms provide positive response.

Compactness

- Facilitates installation.
- Adds to overall sturdiness.

Reproducibility of Parts

- Modern machinery, tools and fixtures; precision manufacturing methods; rigid inspection during processing and assembly — all insure exact reproducibility of parts — uniform performance.

Interchangeable Parts

- Comparable parts interchangeable between all Percentage Parabolic and Percentage V-Port Valves.
- Trim sizes interchangeable among Percentage Piston Valves.
- Springs for 6-30 psi range may be substituted for 3-15 psi range.

Easy to Service

- Serial plate gives full information.
- Yoke removed without disturbing bolted stuffing box.
- Indicator plate marked in ⅛ inch graduations gives true travel indication, correct rated stroke; makes accurate stem readjustment (after disassembly) automatic.
- External type adjusting screw (in sizes 2" and up) for setting spring initial.

For design details and specifications write for bulletin

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These Valves Meet the Rigid Requirements and Specifications of the Most Exacting Users

What to do about high temperature tube problems? Ask the experts!

MORE than one steel may solve your heat, pressure, corrosion and oxidation problems. But only *one* steel can give you the best life/cost ratio.

To get the one steel that gives you maximum tube life per dollar, call on the high temperature steel experts of The Timken Roller Bearing Company. Backed by more than 20 years of research, they have the widest field experience in high temperature applications. With 23 analyses to choose from, they can recommend the *right* tube for your job. And you can be certain of uniform quality because Timken® closely controls quality from melt shop through final inspection.

Let Timken's "RSQ"—Research, Supply, Quality—solve *your* tube problems. *Ask the experts!* Write The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

This month Timken reports on:

DM-2

Recommended as replacement for 0.50% Mo. steel where greater corrosion and oxidation resistance is needed. For use in cracking furnace tubes at temperatures up to 1100° F., high pressure boiler tubing, and high temperature steam piping under conditions where graphitization may occur in 0.50% Mo. steel.

ONE OF 23 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 5S	16-13-3*
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	25-20*
DM-2	2¼% Cr.-1% Mo.	Sicromo 7	25-12*
Silmo	Sicromo 3	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

**Available as seamless tubing on an experimental basis only.*

More than 20 years of research have made Timken the leading authority on high temperature tubing. Photo shows test for linear coefficient of thermal expansion.

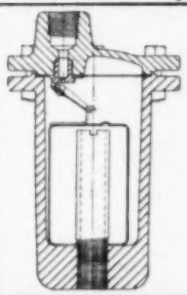
YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

"Here's a Forged Steel Trap . . . for only $14.00 list"

SMALL PRICE
BIG BENEFITS

SAFETY . . . DEPENDABILITY



Cross section of an Armstrong No. 3211 forged steel trap. Forged cap and body, compressed graphited asbestos gasket, all stainless mechanism. This trap will take high temperature and shock without danger of fracture.

SMALL SIZE . . . LIGHT WEIGHT

NOW, for many applications, refineries and natural gasoline plants can have the additional safety of a forged steel steam trap for only a few dollars more than a cast iron trap of comparable size. The Armstrong No. 3211 trap illustrated will withstand fire or explosion without danger of fracture. It is the baby of the Armstrong forged steel line, a low priced trap for working pressures up to 250 psi; design pressure, 450 psi. Capacity range 750 to 1000 lbs/hr continuous. ½" or ¾" pipe connections. Diameter 4¼"; height 7"; weight 8 lbs. This trap is a natural for refinery and natural gasoline plant service.

For higher pressures and larger capacities Armstrong builds a complete line of heavy duty forged steel traps. Ask your nearby Armstrong representative to quote on the traps you need now.

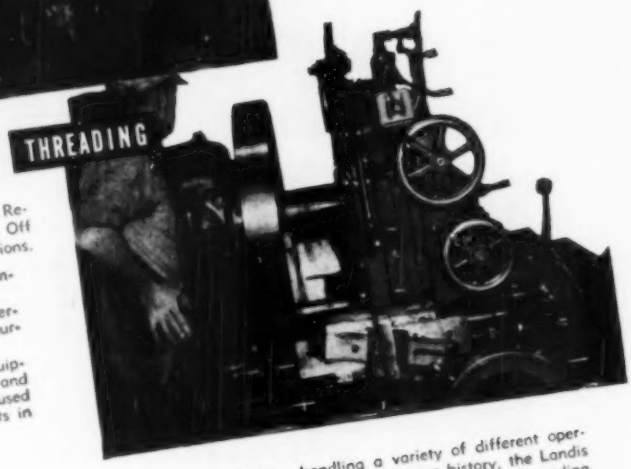
ARMSTRONG MACHINE WORKS
852 Maple St., Three Rivers, Mich.

SEND FOR your copy of the Armstrong Steam Trap Book giving complete data and prices on all Armstrong steam traps, both forged and cast bodies for all pressures, all applications. This 36-page book is a valuable reference for any engineer working with selection and installation of steam traps.

ARMSTRONG STEAM TRAPS

More Jobs Per Dollar Invested

LANDIS PIPE MACHINES do many operations for this Texas Company...



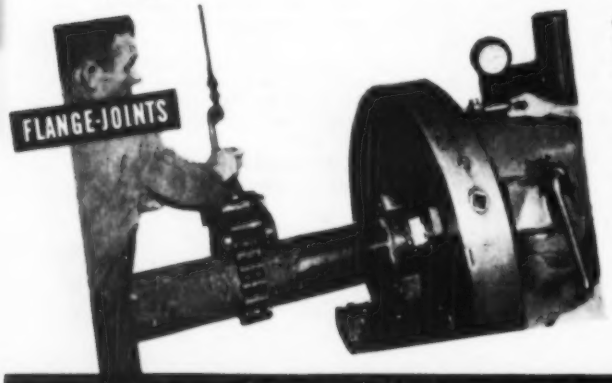
. . . . . saving handling, saving labor, saving machines . . . resulting in dollars saved and dollars earned for this production plant.

Illustrations show the **same** 13⅜" Landis Receding Chaser Pipe Threading and Cutting Off Machine performing three **different** operations.

CUTTING OFF—Casing is cut off, chamfered and then reamed.

THREADING—7" casing to A.P.I. tolerances, using a cutting speed of 18 surface feet per minute.

FLANGE MAKE-UP—Rear chuck is equipped with grip for making up joints and both the front and rear chucks are used for breaking casing or drill pipe joints in oil field work.



Besides handling a variety of different operations, as shown in this case history, the Landis Pipe Machines offer great versatility in threading operations alone. Each size machine handles a wide range of thread diameters. Within this range, and using the same set of chasers, the machine will cut threads of all diameters having the same taper, pitch and form. In addition, these machines are designed to cut tapered threads to precision tolerances. Accurate taper is assured by the sine bar feature, which causes the chasers to be withdrawn at a rate directly equal to the thread being produced.

Landis Pipe Threading Equipment can widen the gap between costs and selling prices in your plant. For complete details and specifications of Landis Pipe Threading Machines and Landis Tangential Chasers, write for Bulletin #C-77.

LANDIS *Machine* COMPANY · WAYNESBORO PENNSYLVANIA

Represented in the Domestic Oil Fields by: Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; C. J. Harter Machinery, Houston, Texas; Frederic-Baker Co., New Orleans, La.; Moore Machinery Co., Los Angeles and San Francisco, Calif.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

28 refinery tested analyses

to meet your specific piping problems

Here are

- Low Carbon
- Low Carbon, ½ Mo
- Low Carbon, 1 Mo
- ½ Cr, ½ Mo
- 1 Cr, ½ Mo
- 1-¼ Cr, ½ Mo
- 2 Cr, ½ Mo
- 2 Cr, ½ Mo, 1-¼ Si
- 2-¼ Cr, 1 Mo
- 2-½ Cr, ½ Mo, ¾ Si
- 3 Cr, ½ Mo, 1-¼ Si
- 3 Cr, 1 Mo
- 5 Cr, ½ Mo
- 5 Cr, ½ Mo, 1-½ Si
- 5 Cr, ½ Mo, Ti
- 7 Cr, ½ Mo
- 8 Cr, ½ Mo
- 8 Cr, 1 Mo
- 9 Cr, ½ Mo
- 9 Cr, 1 Mo
- 12 Cr, Al
- 17 Cr
- 27 Cr
- 18-8
- 18-8 Ti
- 18-8 Cb
- 18-8 Mo
- 25-20

NO matter how unusual your pipe or tube problem, there's a good chance that one of our 28 analyses will solve it. But the important thing to remember is this: each of these analyses was developed to overcome actual conditions of corrosion, oxidation, temperature, pressure, and exposure. In addition, each of these analyses has been thoroughly tested in refinery service. As a result of these installations, we've found out exactly what each will do. And we discovered something else, too: it takes a lot of experience before any one analysis can be recommended as the best and most economical pipe or tube for any particular job.

We've got that experience. Because National Tube Company — world's largest manufacturers of seamless tubular products—has spent over 60 years building up a file of authentic case histories. The endless miles of National Seamless Pipe and Tubes *now in use* have given us a first-hand opportunity to observe the actual performance of refinery tubes under some of the most trying operating conditions known to the industry.

But there's more to refinery tubes than steel analyses. The mechanical strength of the tube is vitally important—and you can't beat seamless tubes for strength. All National refinery pipe and tubes are seamless. They're pierced from billets of high quality steel. This method of manufacture—one of the most drastic forging operations in the industry—assures you of tubes that have absolutely uniform wall strength.

So remember, if you want the best results from your tubes, at the lowest possible cost, submit your problems to our engineers *before* you select new tube requirements. Our huge file of case histories . . . the experience of our engineers . . . are at your service. For more information, write National Tube Company, Frick Building, Pittsburgh 19, Pa.

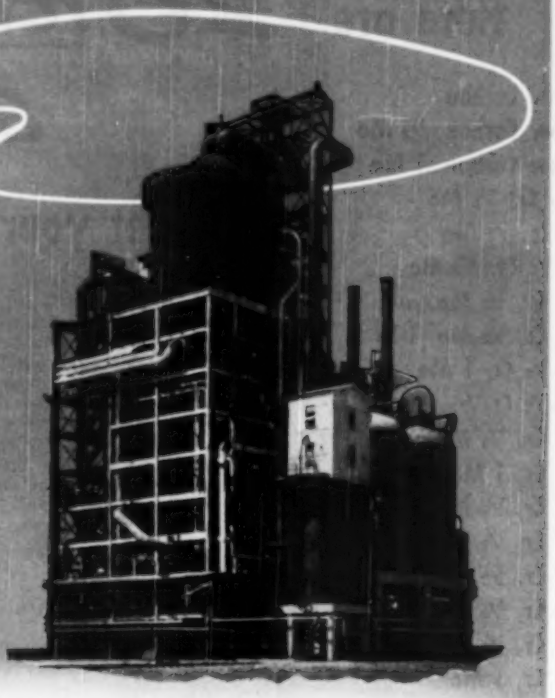
NATIONAL TUBE COMPANY, PITTSBURGH, PA.
(Tubing Specialties Division)
COLUMBIA STEEL COMPANY, SAN FRANCISCO
PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

WHY *Nalcat* SYNTHETIC "FLUID" CRACKING CATALYST WARRANTS SERIOUS CONSIDERATION



Here are typical physical and chemical properties of Nalcat which increase catalyst efficiency in "fluid" cracking units:

	NALCAT Grade 1	NALCAT Grade 2
UNIFORM PARTICLE SIZE		
Typical particle size distribution, percent by weight:		
By Screening Method:		
% Thru 40 Mesh (420 Microns)	100	100
% Thru 100 Mesh (149 Microns)	100	100
% Thru 200 Mesh (74 Microns)	90	70
By Sedimentation Method		
% Total Minus 40 Microns	45	35
% Total Minus 20 Microns	16	10
% Total Minus 10 Microns	4	3
Average Particle Size, Microns	43	56
CHEMICAL PURITY		
Typical analysis by weight percentage, dry basis:		
Loss on Ignition	6.0	6.0
Alumina as Al_2O_3	13.5	13.5
Iron as Fe	.035	.035
Sodium as Na_2O	.015	.015
Sulfates as SO_3	.35	.35
Calcium as CaO	Trace	Trace
HIGH ACTIVITY		
Typical analysis, U.O.P. weight basis	100	100
Apparent bulk density	.41	.45

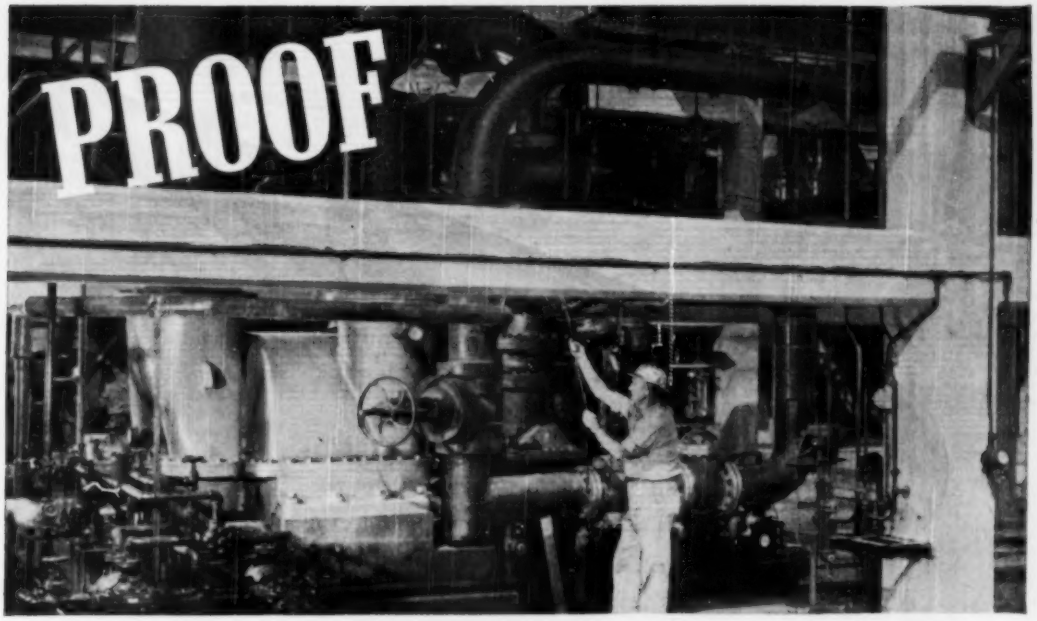
The three outstanding characteristics of Nalcat Silica-Alumina Catalysts listed at left tell their own story to petroleum research and refinery production men. Excellent fluidity of Nalcat is a result of cutting down the percentage of coarse particles to a minimum...Loss of fresh Nalcat is very small because of the low percentage of fines.

Write or call for complete data about Nalcat for use in your "fluid" catalytic cracking unit.

Nalcat

CATALYST DIVISION—NATIONAL ALUMINATE CORPORATION

4001 West 71st Street • Chicago 29, Illinois



...is in Performance!

AT CITIES SERVICE REFINERY, ALLIS-CHALMERS CENTRIFUGAL BLOWERS TURN 85 TIMES A SECOND FOR 1½ YEARS!

IN AN "AROUND THE CLOCK" fluid catalytic cracking plant, equipment reliability is *vital*. Cities Service, Lake Charles, La. depends on seven Allis-Chalmers centrifugal blowers for catalyst aeration. They're rated 22,500 cfm, 17 lb G at 5100 rpm.

Six of the seven were installed in 1943. Two proceeded to set a record of 540 days, 24 hrs a day, continuous operation: being shut down only for drive inspection! Two others ran for 562 days before scheduled inspection shutdown! Only routine maintenance has been required on all seven to date.

These blowers are still on the job, 24 hrs a day, helping produce motor, premium and aviation gasoline for the widespread operations of Cities Service. Output is at constant volume, automatically maintained by variable speed 2200 hp steam turbine drives.

Here are the reasons for the low maintenance and high dependability of A-C centrifugal blowers:

PURE ROTARY MOTION — precisely balanced impeller is only moving part.

FRICTION FREE INTERIOR — bearings outside casing, no internal mechanical wear.

SIMPLE LUBRICATION — oil under pressure in closed circuit, consumption low.

STRONG CONSTRUCTION — forged steel shaft, alloy steel high speed impeller reduces unit size, weight.

CAST IRON CASING — makes blower rigid, smooth, quiet.

THOROUGH TESTING — impeller given severe over-speed test, blower factory tested at maximum speed.

For this kind of highly dependable, low maintenance air and gas handling equipment, call your nearest A-C office or write direct for literature.

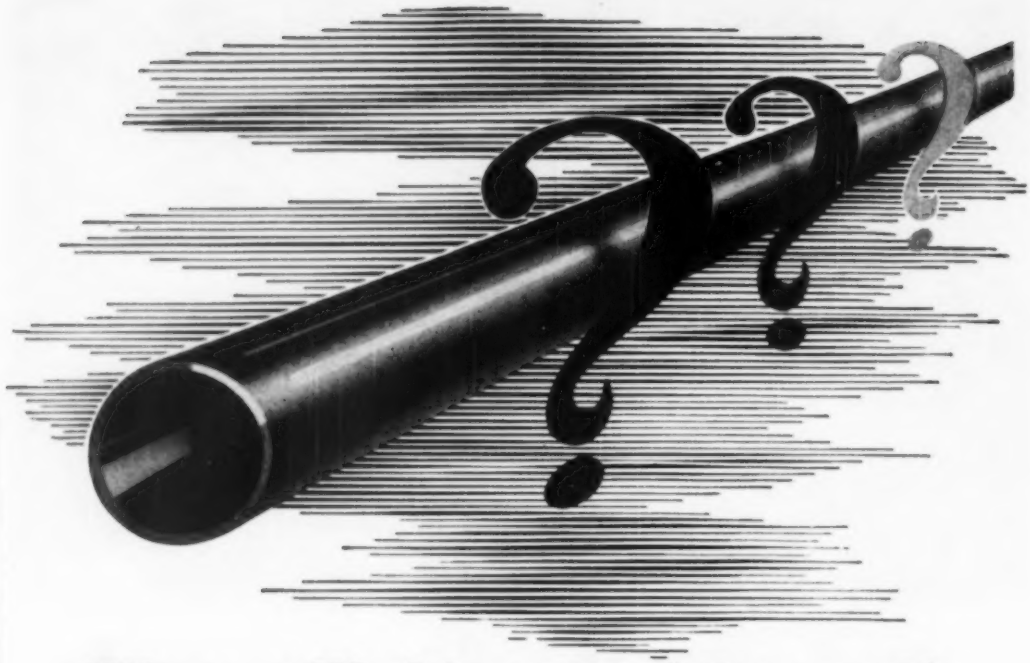
ALLIS-CHALMERS, 1062A SO. 70 ST. MILWAUKEE, WIS. A-3030

Texrope is an Allis-Chalmers trademark.

ALLIS-CHALMERS

Power, Electrical, Processing Equipment for Petroleum Industry

TURBINE GENERATORS · BLOWERS and COMPRESSORS · TRANS FORMERS · UNIT SUBSTATIONS · MOTORS—*TEXROPE* DRIVES-CONTROL · CENTRIFUGAL PUMPS



When will this tube "give up?"

This is a question which you might well ask as you see the tube about to be installed in your condensers.

How long will the tube last before it will require replacement?

When you ordered it, you specified it by length, size and certain alloy. It was delivered to you according to those specifications. That part you can check.

But that isn't the all-important consideration of a purchase of tubing. There is something else included in that delivery.

Surely the factors that interest you most are not alone the physical characteristics of the tube, but rather the period of time it will continue to serve you—its FUTURE LIFE EXPECTANCY. Upon THAT depends the economy and efficiency of your installation.

Therefore, on your next order, be sure to specify "Wolverine" along with the other specifications, such as alloy, diameter, etc. Stipulating the name "Wolverine," you'll receive a seamless non-ferrous tube, quality controlled from ore to finished product.

Far in the future you will see this Wolverine tube still carrying on with traditional dependability long after ordinary tube has given up.

The name "Wolverine" on your orders will mean a lot to you.

We'll be glad to send you our brochure "Condensers" if you ask for a copy.

WOLVERINE TUBE DIVISION
Calumet & Hecla Consolidated Copper Co.
INCORPORATED
Manufacturers of Seamless Non-Ferrous Tubing
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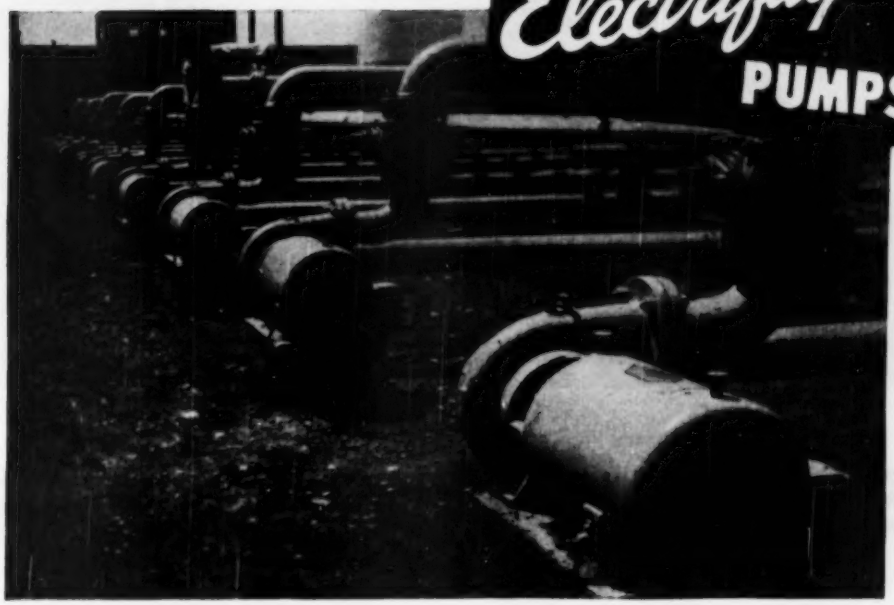
PLANTS IN DETROIT AND DECATUR, ALA.
Sales Offices in Principal Cities

Cut Petroleum Pumping Costs With *Electrifugal* PUMPS



1 SAVE ON INSTALLATION! *Electrifugal* pump comes ready to connect and run. No extra parts. Easy to handle. Requires small installation space.

2 SAVE ON OPERATION! Pump and motor designed together for high efficiency. Every unit tested at factory and guaranteed to deliver rated capacity.

3 SAVE ON MAINTENANCE! Motor and pump have single shaft — assuring perfect and permanent alignment. Parts easily accessible. Has fewer parts and machined fits.

Electrifugal and *Texrope* are Allis-Chalmers trademarks.

OVER 42,000,000 GALLONS OF PETROLEUM PRODUCTS are pumped annually through 15 Allis-Chalmers close-coupled pumps at this new midwest bulk station.

Distribution failures are avoided through the dependable service of these "one-package" pump-motor units. Bronze wearing ring protects casing from wear and is easily replaced when required.

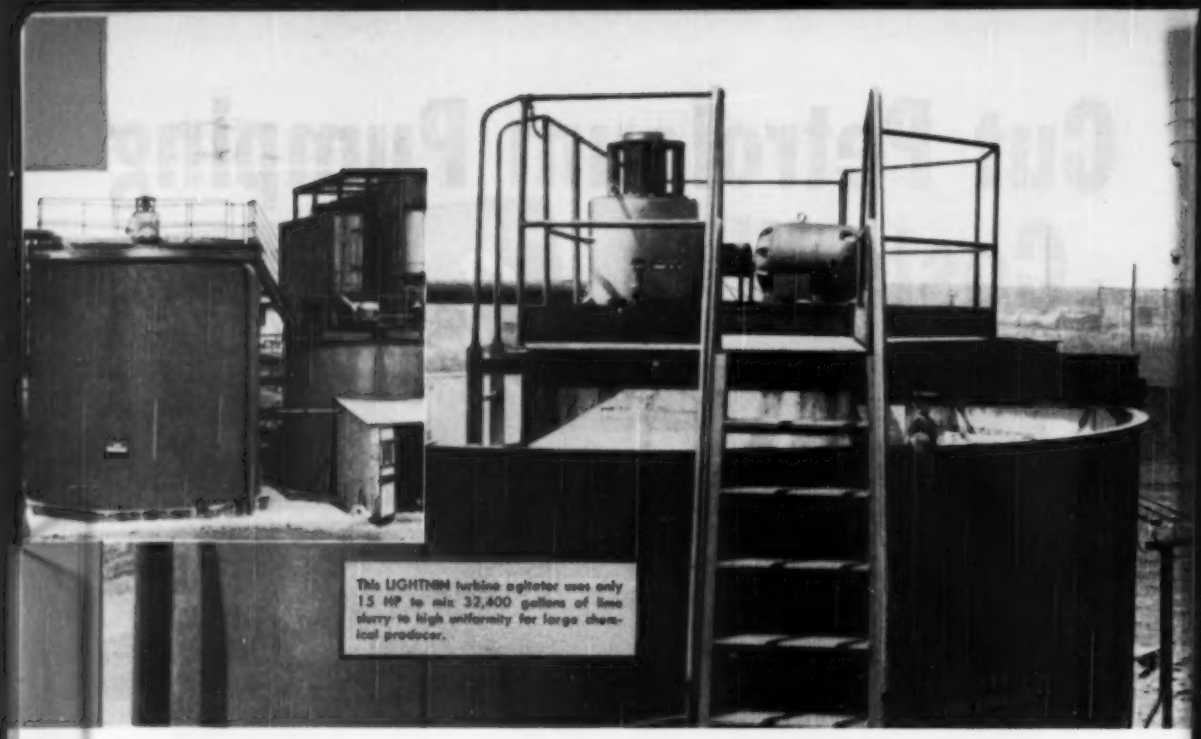
Electrifugal pumps range from 10 to 1600 gpm with heads to 525 ft. For information, see your Allis-Chalmers Authorized Dealer or Sales Office. Or write for Bulletin 52B6059E. A-2974

ALLIS-CHALMERS, 1062A SO. 70 ST. MILWAUKEE, WIS.

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

Power, Electrical, Processing Equipment for Petroleum Industry



This LIGHTNIN turbine agitator uses only 15 HP to mix 32,400 gallons of lime slurry to high uniformity for large chemical producer.

SUSPENDING SOLIDS . . . a precision job

A LIGHTNIN Agitator, combined with MIXCO engineering, saves this large chemical company plenty on a "tough" solids suspension problem.

MIXCO agitation specialists showed this processor how he could suspend lime uniformly in an 18-foot, 34,265-gallon tank—using only 15 horsepower . . . with *standard* equipment . . . and *without* the cost or upkeep of a step bearing!

This is just one example of what MIXCO agitation engineering can do for *you*—process-wise . . . maintenance-wise . . . cost-wise. If you handle fluids within tanks, MIXCO can help you. Only MIXCO gives you the benefit of 25 years' fluid agitation experience . . . an impressive record of service to process industries . . . backed by research data that enable you to *know in advance* the results you will get.

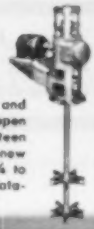
That's why MIXCO is glad to take *full responsibility* for the success of every installation of LIGHTNIN Mixers.

If you are shooting for faster production, closer control, or reduced labor and upkeep costs, consult MIXCO first. Check the processes you use, or plan to use, and write us for facts on agitation that does what you want it to do. Write today. Your letter will receive prompt, courteous attention by MIXCO engineers.

A COMPLETE LINE . . . PLUS UNEXCELLED TECHNOLOGY

LIGHTNIN PORTABLE MIXERS
World's largest-selling line. Electric or air motor; direct or gear drive. Sizes ⅛ to 3 HP. Send for Catalog B-75.

LIGHTNIN SIDE ENTERING MIXERS
For tanks up to 5 million gallons. Gear motor or V-belt drive; motorless types. Sizes 1 to 25 HP. Send for Catalog B-76.



LIGHTNIN TOP ENTERING AGITATORS
Turbine, propeller and paddle types. For open or closed tanks. Sixteen speeds available in new heavy duty drive. ¼ to 200 HP. Send for Catalogs B-89, B-78.

"Lightnin" Mixers — GIVE CONTINUOUS UNIFORMITY, WITHOUT BOTTOM BEARING, IN TANK 18 FEET DEEP

APPLICATION DATA:

OPERATION: Make up lime slurry and suspend as milk of lime, for further process operations.

COMPONENTS	CONCENTRATION	SP. GR. OF MIX
Unslaked Lime	2 Lbs. Lime per Gal. of Water	1.25
Water		

BATCH: 32,400 Gals. Max.; 8,100 Gals. Min.

TANK: Cylindrical, flat bottom, diameter 18', straight side 18'.

BATCH RATIO: 0.25

APPROX. FALLING RATE OF LIME: 1.0 Ft./Min.

MIXCO Analysis: Laboratory work with a test model, operating in a transparent tank, indicated that a power input of 15 HP would suspend the lime satisfactorily, although tankage of this size would normally require 25 or 30 HP. The abrasive nature of solids made a step bearing impractical.

Solution: LIGHTNIN Model 3D-WQ-1500, 15-HP Turbine Agitator, providing output shaft speed of 59 RPM.

Two 38" multi-blade radial flow turbine impellers were selected, with lower turbine 12" off tank bottom to provide low-level operation. Upper turbine was carried proper distance above lower turbine, in an extended keyway to permit vertical adjustment to yield optimum results. Lower turbine was fitted with a correctly sized stabilizer ring, giving stable operation of the 18' overhung shaft, even during draw-off.

Pumping capacity of 188.2 Gals. per revolution for each turbine, when modified by the proximity factor, gave a total discharge of 18,000 GPM, equivalent to approximately one-half tank turnover per minute.

Results: High uniformity of suspended solids. There is no appreciable difference in lime content of the first and last thousand gallons drawn from tank. User is well pleased after more than a year's continuous operation.

done better with "Lightnin® Mixers"

MIXCO® Engineered

WHAT MAKES A GOOD SUSPENSION

POOR . . . Impeller in unbaffled tank creates deep vortex. Swirling liquid leaves solids heavily concentrated in bottom. Result: poor uniformity; overloading of filters, pumps and other equipment in the system; costly time and power waste.

Photos taken at 1/25,000 second.

GOOD . . . MIXCO combines proper baffling with correct impeller size, design and location, plus just enough power to lift particles from bottom and suspend them uniformly. Result: tremendous savings in process time, power consumption, and equipment maintenance.

PROCESS ADAPTED AGITATION · TOP-ENTERING · LIGHTNIN MIXCO · PORTABLES · SIDE-ENTERING

For descriptive literature on ***LIGHTNIN Mixers,*** *check and mail coupon today*

MIXING EQUIPMENT CO., Inc.
(MIXCO)
1064 GARSON AVENUE · ROCHESTER 9, N. Y.
IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

MIXING EQUIPMENT CO., INC.
1064 GARSON AVE., ROCHESTER 9, N. Y.

Please send me the literature checked:

- ☐ B-76 Side Entering Mixers
- ☐ B-78 Top Entering Mixers (Propeller Type)
- ☐ DH-50 Laboratory Mixers
- ☐ B-89 Top Entering Mixers (Turbine and Paddle Type)
- ☐ B-75 Portable Mixers (Electric and Air Driven)

Name .....

Title .....

Company .....

Address .....

City ..... Zone ..... State .....

In Laboratories, too . . .

THE VERSATILE

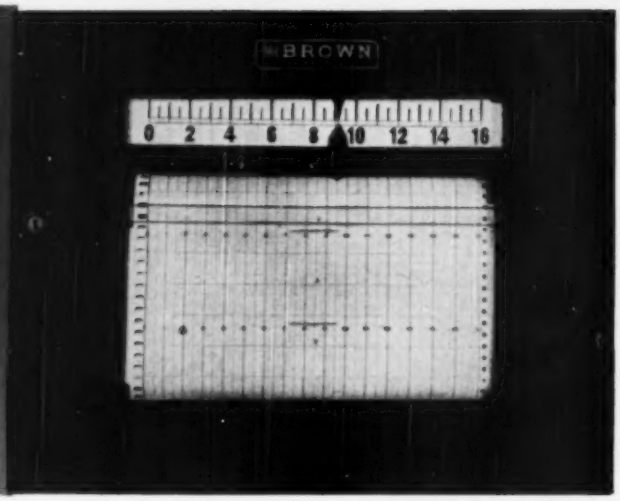
Electronik

STRIP-CHART

RECORDER

IS DOING A

MAN-SIZE JOB!

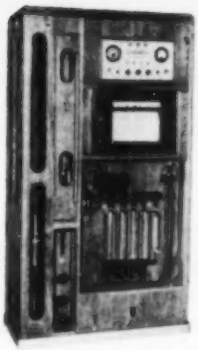


WITH a background of more than 10 years of outstanding service in process work, throughout industry, the *ElectroniK* Recorder is now rapidly gaining recognition as a valuable component of precision laboratory equipment.

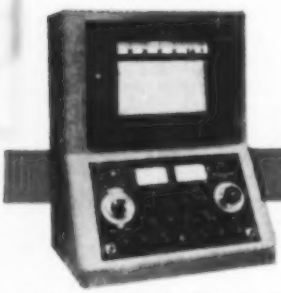
In research *and* analytical work, its unique versatility makes it a "natural" for literally thousands of different applications . . . limited at the present time only by the speed with which alert manufacturers learn to take advantage of its remarkable sensitivity, great accuracy, unusual ruggedness and complete dependability.

Bulletin B 15-10, now available, describes the adaptability of the measuring circuit, the input circuit and the amplifier of the *ElectroniK* Potentiometer. Write for your copy, or call in your local Honeywell engineer for a discussion of your specific application . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4498 Wayne Ave., Phila. 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

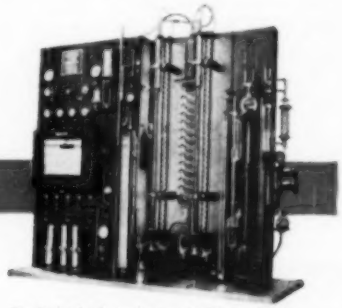


The Turner-Burrell Fractionator, with *ElectroniK* Recorder, used for analyzing light hydrocarbon mixtures. *Write for Data Sheet 10.16-6.*



The Sargent Polarograph, with *ElectroniK* Recorder, used for the qualitative and quantitative analysis of compounds subject to electrolytic oxidation and reduction. *Write for Data Sheet 10.16-5.*

The General Electric Mass Spectrometer, with *ElectroniK* Recorder, used for the qualitative and quantitative analysis of gases. *Write for Data Sheet 10.16-11.*



The Podbielniak Analyzer, with *ElectroniK* Recorder, used for recording and controlling a variety of distillation variables. *Write for Data Sheet 12.6-1.*

FOR THE PETROLEUM INDUSTRY

Honeywell

BROWN INSTRUMENTS

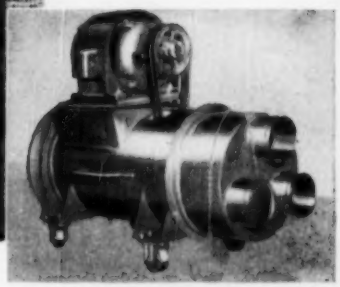
This 22-Foot Hartzell Cooling Tower Fan Can Give You . . . . 1,250,000 C.F.M.

Not one Hartzell Cooling Tower Fan of Hartzite Plastic has ever failed unless obviously abused . . . **NOT ONE**

Shown on the Hartzell test stand is the new Hartzell 22-foot Cooling Tower Fan. Blades are of Hartzite plastic, which has proved itself to refiners so convincingly on Hartzell fans up to 20-foot diameter. It was run continuously at 125% of its rated speed on test; stresses developed were 55% greater than are encountered in service. It delivered 1,250,000 cfm at 180 HP.

This truly great new fan, on which we are now making deliveries in the sequence in which orders are received, will give you maximum cooling power per cubic foot of tower. Power cost per cubic foot of air moved is relatively low.

If you build or buy cooling towers using fans of 3' to 22' size, specify Hartzell. If you've had trouble with fans in existing towers, replace with Hartzell. Your troubles will end!



PORTABLE BLOWER CLEARS FUMES FROM TANKS

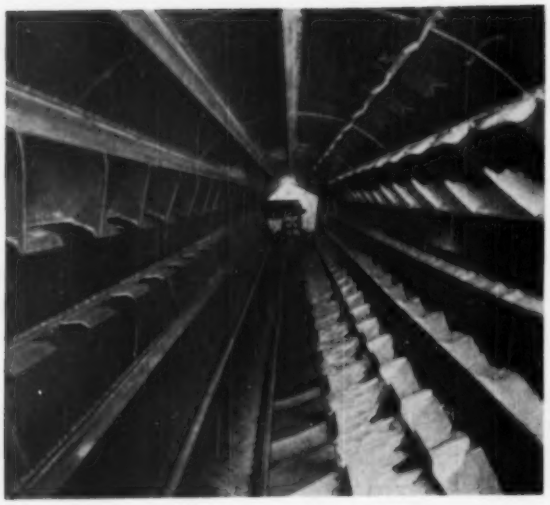
Shown above is a Hartzell Vaneaxial Blower "on casters." Easily lifted by two men; compact, powerful. Specially mounted by Hartzell to clear fumes from gasoline tank trucks before and during interior welding repairs. Each of three portholes, any or all of which can be used at one time, delivers approximately 500 cfm through a 15-foot long 5" hose. End assemblies easily reversible for exhausting or blowing. Other capacities can be produced.

CLIP AND MAIL COUPON NOW FOR INFORMATION

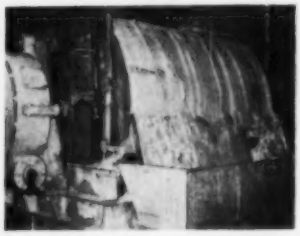
HARTZELL PROPELLER FAN CO.
Div. of Castle Hills Corp.
PIQUA DEPT. J OHIO

Name_____
Company_____
Street & No._____
City & State_____

PROPELLER-TYPE FANS AND BLOWERS — ROOF VENTILATORS — UNIT HEATERS • ENGINEERING OFFICES IN PRINCIPAL CITIES



Linings and flights of this rotary salt dryer at the Worcester Salt Company are made of Monel.



Filter used in the production of fertilizer from potassium chloride-sodium chloride mixtures. All contact parts are Monel.

Handling salts...brine?

Here's how to cut corrosion losses

If sodium chloride or alkali salts are eating holes in your maintenance budget, here's something you should know . . .

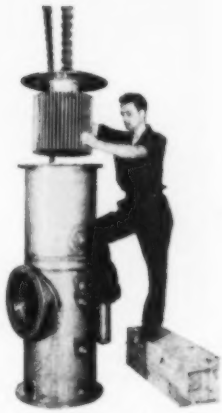
Monel® . . . practical, economical, workable . . . has for many years stood the severe test of actual industrial usage in handling corrosive salts.

In the presence of salts such as sodium chloride, *Monel* shows an economical corrosion rate.

Common alkali salts (hypochlorites excepted) and acid salts, such as zinc chloride, ammonium sulfate, aluminum sulfate, and ammonium chloride, may be handled under many conditions in *Monel* equipment.

Typical applications of *Monel* and *Monel*-Clad Steel in these fields are: dryers, vacuum evaporator tubes, saturators, pumps, ejectors, centrifugal driers, crystallizers, storage tanks, piping, screens, filters, feed-water pumps, valves and valve parts.

Monel is produced in many standard mill forms—sheet, strip, tube, angles, rod, wire castings and forgings. For specific information for your application, write directly to Inco.



Water still used aboard U. S. Coast Guard light ships, for distilling fresh water from sea water. All parts and piping vulnerable to corrosion are made of Monel.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE

INCO

TRADE MARK

MONEL . . . *for Minimum Maintenance*

1951
48,000 bbl/day

another one . . .

1949
48,000 bbl/day

. . . like this

1940
30,000 bbl/day

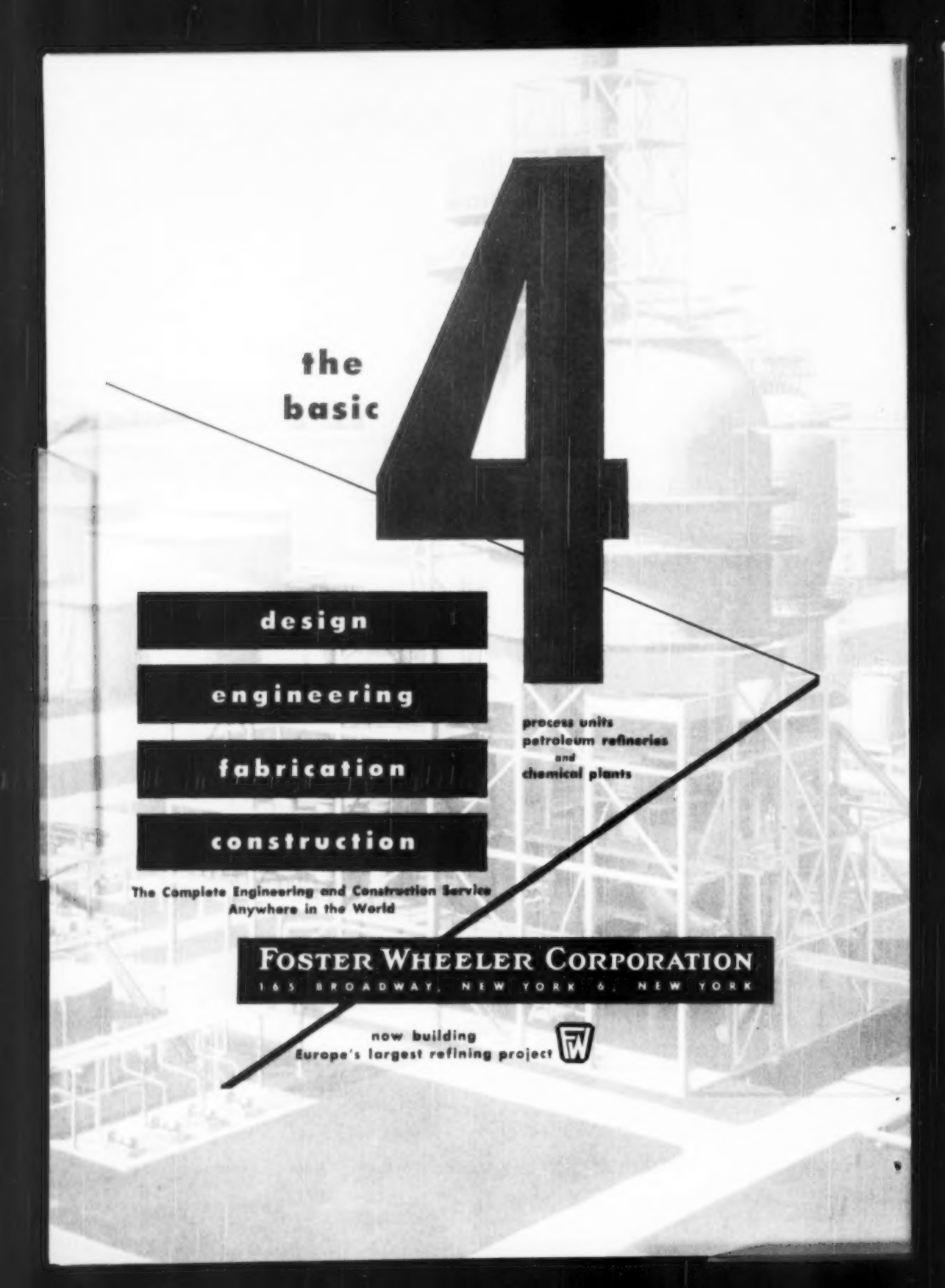
A sound design lives on . . .
. . . and is reproduced many times

The design of the 1940 unit was "right",—it was duplicated, essentially, in the 1949 unit,—it will be reproduced again in the 1951 unit.

These three crude distillation units are products of the complete engineering and construction service that is Foster Wheeler and were designed and constructed for a major Gulf Coast refiner in collaboration with the engineering department of that company.

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK


the
basic
4
design
engineering
fabrication
construction
process units
petroleum refineries
and
chemical plants
The Complete Engineering and Construction Service
Anywhere in the World
FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, NEW YORK
now building
Europe's largest refining project

GARLOCK 7021
Compressed Asbestos Sheet Packing

Superior Performance

Top performance is the result of ability, experience and extra effort. GARLOCK Sheet Packings are superior gasketing materials because of careful selection of raw materials, experienced workmanship and constant quality control.

GARLOCK 7021 Compressed Asbestos Sheet is exceptionally strong and tough. Gives superior service against gasoline, oil, gas or steam at high temperatures and extreme pressures.

GARLOCK 22 Red Rubber Sheet Packing is tough and resilient. Specially recommended for hot or cold water and low pressure steam joints.

GARLOCK 660 Cork-Fibre Sheet Packing combines granulated cork and vegetable fibre into a strong compressible sheet; treated with an oil resistant binder. An ideal gasketing material for oils and solvents at temperatures up to 212°F.

GARLOCK 22 Red Rubber Sheet Packing

GARLOCK 660
Cork-Fibre
Sheet Packing

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
Tulsa, Okla. Houston, Texas
Los Angeles, Calif.

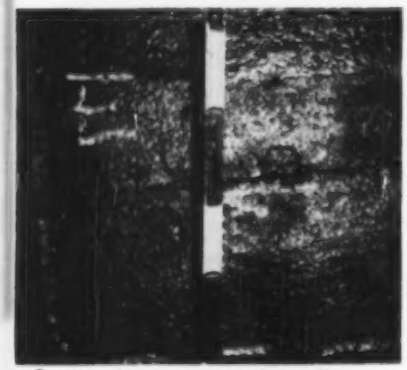
GARLOCK SHEET PACKINGS

CHLORINATION BY WALLACE & TIERNAN

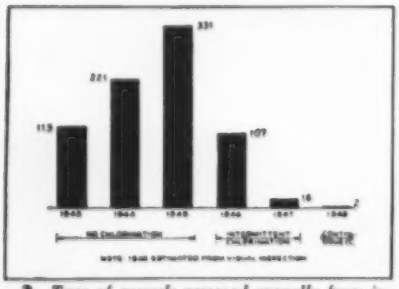
CONTROLS MARINE FOULING AT GENERATING STATION

LOOK AT THESE RESULTS

1. Before chlorination — mussels cover wall to depth of 3".



2. After chlorination — note bare wall.



3. Tons of mussels removed annually from intake tunnel of generating station.

It all began when a New England generating station sent down a diver for a routine inspection of the large, concrete, circulating-water, intake tunnel located approximately 13 feet below the harbor's surface. The diver discovered this intake was lined with unusually heavy growths of common mussel (Mytilus), sea moss (Tubularia), and sea anemone (Metridia).

These were expensive visitors. First, mussel accumulation created poor vacuum as the mussels lodged in condenser tubes and aggravated slime and silt formation. Then, as the mass increased in quantity, it became necessary to clean the intake tunnel every year to remove up to a maximum of 331 tons of mussels — a time consuming process that cost thousands of dollars in labor and equipment outage.

To combat these conditions a long and thorough study was made of marine fouling. As a result it was decided to use intermittent chlorination applied by Wallace & Tiernan Chlorinators. First to fall under this attack were the sea moss and the sea anemone. The tougher mussels however, still remained as numerous as ever.

In an all out effort to get rid of these trouble makers, continuous chlorination at heavier residuals was started. This treatment turned the trick and the mussels were reduced to such a low level that yearly cleaning has not been required.

These results saved the New England company thousands of dollars annually by eliminating intake tunnel cleaning, reducing condenser outages, and producing a higher vacuum with a resultant saving in fuel.

Perhaps your problem is one of slime or fouling due to some other marine organism. In any event, if biological fouling is costing you money through lowered cooling water efficiency it's a safe bet that chlorination can help.

See your nearest Wallace & Tiernan Representative now for all the details.

CD-34

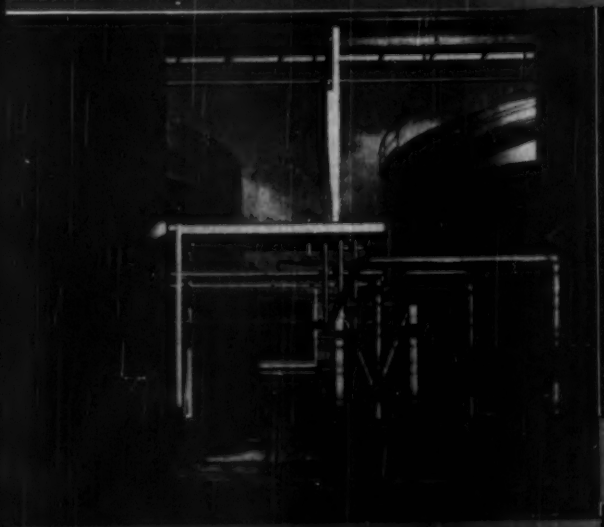
WALLACE & TIERNAN
PRODUCTS, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
Belleville 9, New Jersey • Represented in Principal Cities

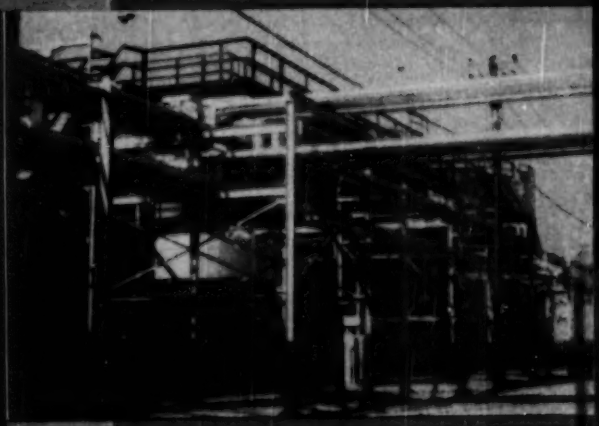
EVERY JOB IS A MATTER OF

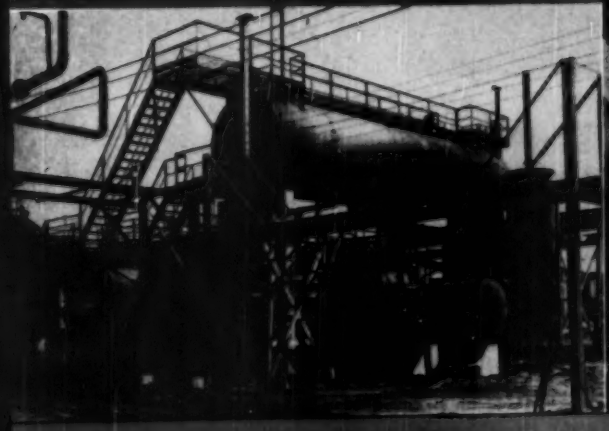
PERSONAL PRIDE

WITH

ELLERBEE BROTHERS





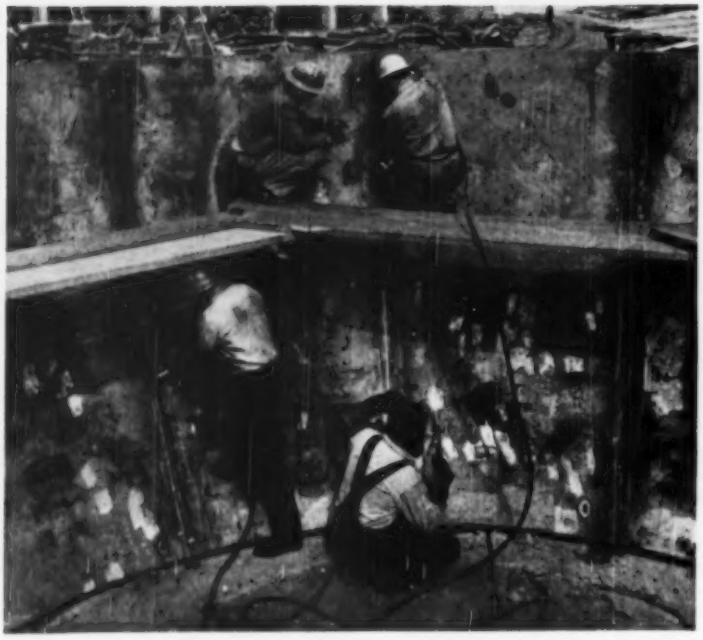


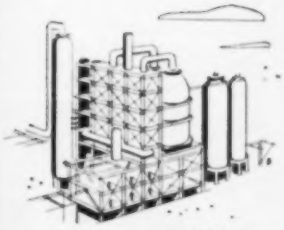
For more than 20 years, members of the Ellerbee Brothers organization have worked with structural steel and erection of tanks. Since the Ellerbee Brothers organization was formed, they have used their rich backlog of experience in completing contracts for most of the major oil and chemical companies on the Gulf Coast.

Personal supervision . . . and personal pride in each job . . . adds the finishing touch to every Ellerbee Brothers job. Write for the Ellerbee Brothers brochure. It gives a complete background on the organization.

ELLERBEE BROTHERS

Enduro® STAINLESS STEEL





THRIFTY METAL OF 10,000 USES

In cracking towers, hot oil lines, expansion joints, bubble caps and trays, vapor risers, swing lines, ENDURO adds up to operation with efficiency and economy. It is matched perfectly to the rugged requirements of petroleum refining.

SEAMS TO LAST

Down to the last weld of the last seam there's positive resistance to rust and corrosion—when it's ENDURO Stainless Steel. No weakness here! These seams will hold as long as the walls themselves—they'll last indefinitely.

The strength-to-weight ratio of ENDURO is unusually high. Withering heat does not faze it. Explosive force and punishing pressures are held in check. To these rugged characteristics add corrosion- and rust-resistance and you have a combination that can be depended upon to keep equipment "on stream."

When you specify ENDURO for refinery equipment, the initial cost may be slightly higher than for less effective materials. However, through low maintenance costs, continuous operation, and unusually long life, this premium quickly converts to a dividend and continues to pay off indefinitely. Ask your equipment manufacturer for information and estimates on ENDURO. Today is not too soon!

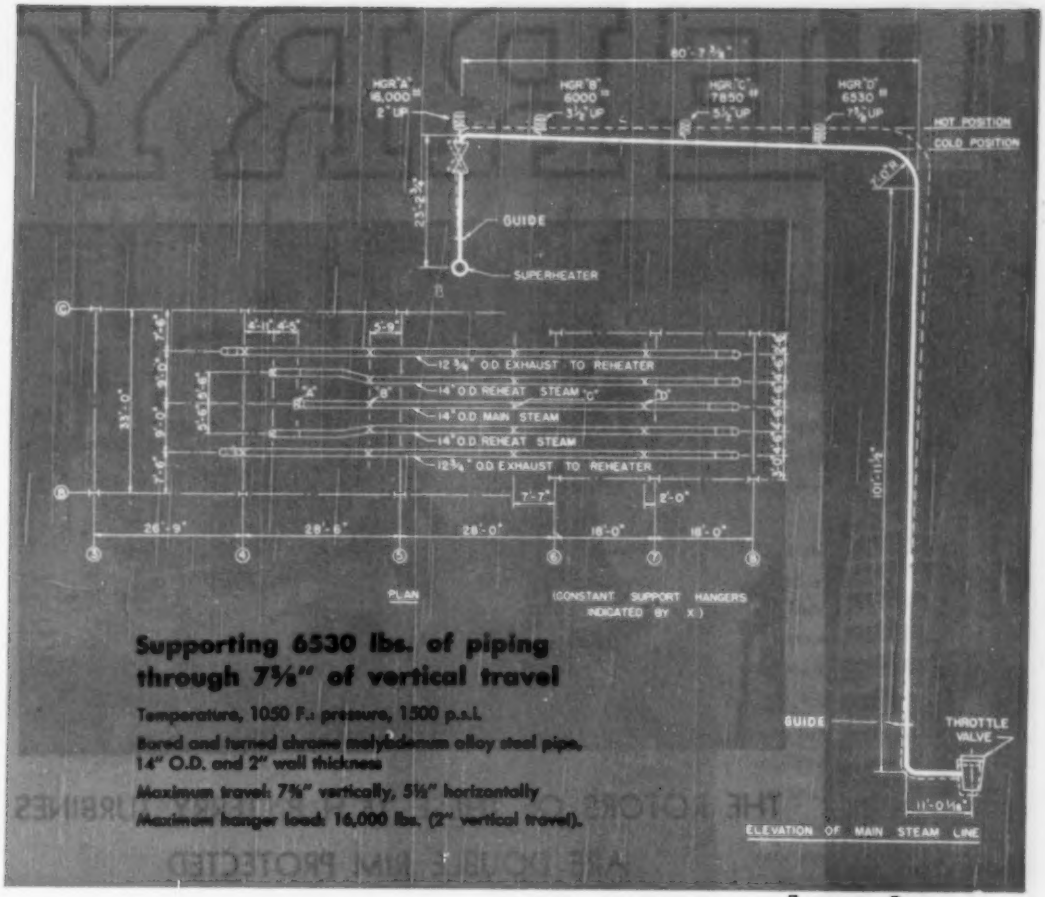
✓ **CHECK ALL 12 ADVANTAGES: Rust- and Corrosion-Resistance • Heat-Resistance • High Melting Point • Low Coefficient of Expansion • High Strength • Good Dimensional Stability • No Metallic Contamination • Easy to Clean • Easy to Fabricate • Eye Appeal • Long Life • Low End Cost • *What more can be desired in a material?***

REPUBLIC STEEL

For Complete Details Write

REPUBLIC STEEL CORPORATION

Alloy Steel Division, Massillon, Ohio • GENERAL OFFICES, CLEVELAND 1, OHIO • *Export Dept.: Chrysler Bldg., New York 17, N.Y.*



Supporting 6530 lbs. of piping through 7⅝" of vertical travel

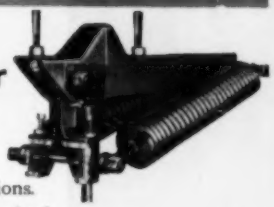
Temperature, 1050 F.; pressure, 1500 p.s.i.

Bored and turned chrome molybdenum alloy steel pipe, 14" O.D. and 2" wall thickness

Maximum travel: 7⅝" vertically, 5½" horizontally

Maximum hanger load: 16,000 lbs. (2" vertical travel).

ONLY a Grinnell Constant-Support Hanger solves this problem easily, practically



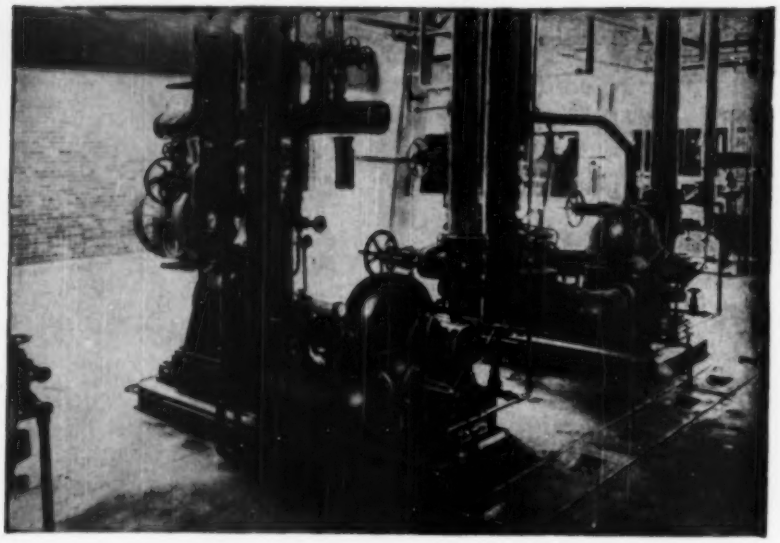
Provides constant support to piping subject to vertical movement — in all hot and cold positions. Maintains full safety factor in supporting high temperature, high pressure piping. Non-resonant and energy absorbing. Mass-produced from standard precision parts. Individually calibrated for each installation. Load-adjustment features incorporated into design. Models to meet entire range of load-travel specifications. Minimum headroom required.

Believing that a good piping job is too important to be jeopardized by improvised or inadequate pipe hangers, Grinnell has developed a complete line of stock hangers and supports for every piping need from a simple water pipe to a high pressure, high temperature steam line. Write for Catalog 10-D.

GRINNELL

Grinnell Company, Inc., Providence, R. I. Branches: Atlanta • Billings • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

TERRY



THE ROTORS OF THESE 75 H. P. TERRY TURBINES ARE DOUBLE RIM PROTECTED

The two 75 H.P. Terry Turbines shown above (in the plant of a leading refiner) employ the Terry Solid Wheel Rotor. The wheel is made from a single steel forging and the buckets are milled directly into the wheel. — All as shown in the illustration at the left.

The buckets are protected by rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the clearance became reduced.

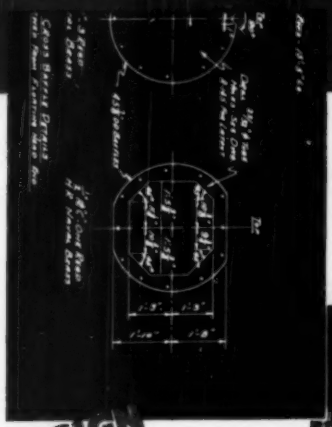
With this construction it is impossible for the blades to foul and frequent inspections of the thrust bearing are not required to obtain safe and dependable operation.

This feature and many others of the Terry Wheel Turbine are fully discussed in our Bulletin S-116.

T-1160

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

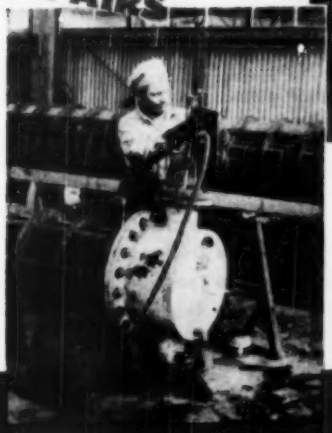
HEAT EXCHANGERS



DESIGN

CONSTRUCT

REPAIRS



Texas Metal Fabricating Company specializes in rendering prompt and efficient service to the refineries, gas process, and other industrial plants throughout the Gulf Coast area.

Competent craftsmen and excellent shop facilities combined with years of experience in heat transfer equipment are available to you night and day.

It has been our privilege to serve many of the major companies throughout the Southwest in their heat exchanger and pressure vessel requirements.

Your inquiries are most cordially invited, and we promise they will receive our very prompt and careful attention.

API—ASME and ASME Code Construction

Qualified for Construction in Ferrous and Non-Ferrous Materials

TEXAS METAL FABRICATING COMPANY

HOUSTON

As easy as pulling a cork...

Powerful Annin Domotor Operator Provides Positive Valve Action

Even if you had a force differential of *two tons* across the valve seat, the Annin Domotor Operator would lift the valve plug like Atlas pulling the cork out of a bottle. This amazingly powerful operator depends on internally controlled differential pressures acting across a sealed-in piston to *accurately* and *positively* position the valve plug according to instrument pressure. The entire effect of the supply pressure is available to move the valve plug anywhere from wide open to bubble-tight shut off.

ANNIN DOMOTOR CONTROL VALVES

The powerful Domotor assembly is direct connected to the popular single-seated valve body. Apart from the unique Domotor assembly, Annin valves have many outstanding features:

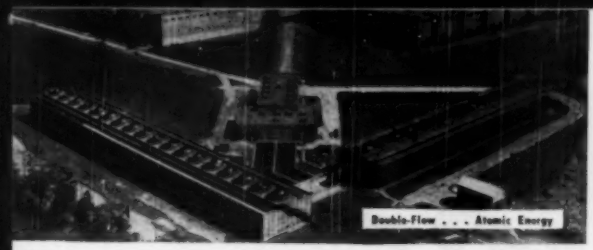
- **Choice of flow characteristics**
- **Teflon or metal seal**
- **Teflon stem packing**
- **Low pressure drop across valve**
- **Low maintenance costs**
- **Available in wide range of alloys**
- **Pressures to 3000 psi**
- **Temperatures to 1000°F**
- **Handles slurries and sludges**

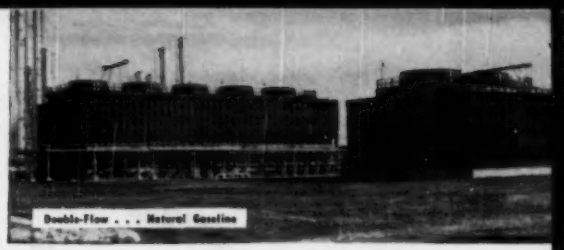
If you are looking for a valve to positively control hard-to-handle fluids specify the modern Domotor Control Valve.

It will pay you to investigate Annin Valves

THE ANNIN COMPANY

3500 UNION PACIFIC AVENUE, LOS ANGELES 23, CALIFORNIA


Double-Flow . . . Atomic Energy


Double-Flow . . . Natural Gasoline

WHAT IS YOUR COOLING PROBLEM?

Spray Pond . . . Refinery

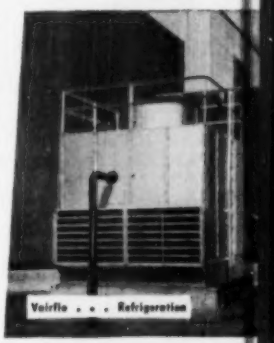
Conventional . . . Pipe Line

IS IT COST? Cooling towers or DriCoolers can have a low first cost with higher operating cost and vice versa. Or, you can get an economical combination of both. Marley application engineers have a complete line of units to select from and the "know-how" to help you make the best selection for your purpose.

DriCooler . . . Diesel Cooling

IS IT SPACE? Marley equipment may be installed indoors or outdoors. Units are available with large base area and low height to give light loading per square foot or with small base area and greater height to fit in small area.

IS IT TEMPERATURE? Usually, it is not economical to cool lower than a 5F approach to the wet bulb. However, in Marley cross-flow towers a quantity of water at wet bulb temperature may be obtained without added cost. For high level cooling, the DriCooler is applicable.


Vairflo . . . Refrigeration

IS IT LOCATION? Extreme temperatures, cold or hot, dust, wet bulb, altitude, brackish water, wind, storm conditions, or lack of proper water supply are problems that must be considered. Marley has a unit to fit any geographical condition.

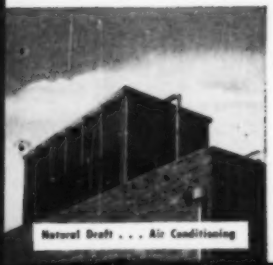
Double-Flow . . . Power

IS IT APPEARANCE? Marley has a wide range of designs that will blend with any building architecture. Or even become a part of the building itself. Marley engineers can help your architect give you a good looking as well as efficient installation.

These are only a few of the problems you may face in the selection of a cooling tower or DriCooler. No matter what the problem, Marley Application Engineers have the answer to help you invest your dollars wisely and profitably.

DriCooler . . . Gas Cooling

MARLEY


Natural Draft . . . Air Conditioning

PR-9

Write, Wire or Phone The Marley Company, Inc., Kansas City 15, Kansas.

Name _____ Title _____

Company _____

Address _____

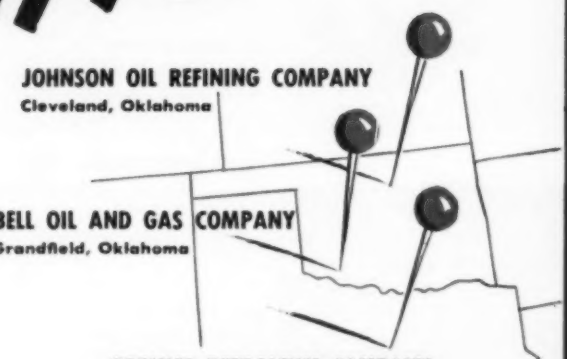
City _____ Zone _____ State _____

☐ Please send "What's Your Cooling Tower IQ"

☐ Our Cooling Problem is _____

Aquatower . . . Air Conditioning

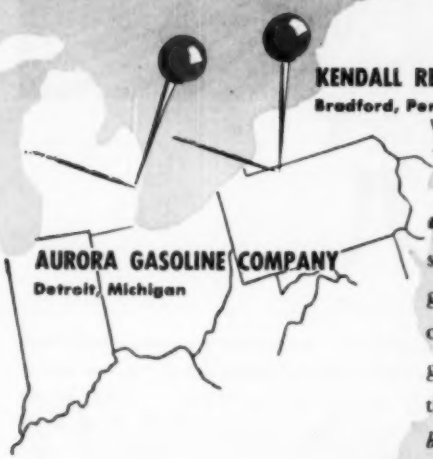
5 MORE PLATFORMING UNITS



JOHNSON OIL REFINING COMPANY
Cleveland, Oklahoma

BELL OIL AND GAS COMPANY
Grandfield, Oklahoma

PREMIER PETROLEUM COMPANY
Fort Worth, Texas



■ In a matter of months Platforming has proved its superiority in octane improvement of straight run gasolines . . . in the production of a blending component of unequalled quality . . . in the building of new gallonage records. So conclusive has this proof been, that *five more Platforming units are now being built from Texas to Pennsylvania.*

These progressive refiners installing the Platforming process have realized the advantages provided by the improvement of low octane straight run gasolines. Soon they will be providing their markets with a higher quality product . . . increasing gallonage at the point of sale and substantially building a more profitable operation.

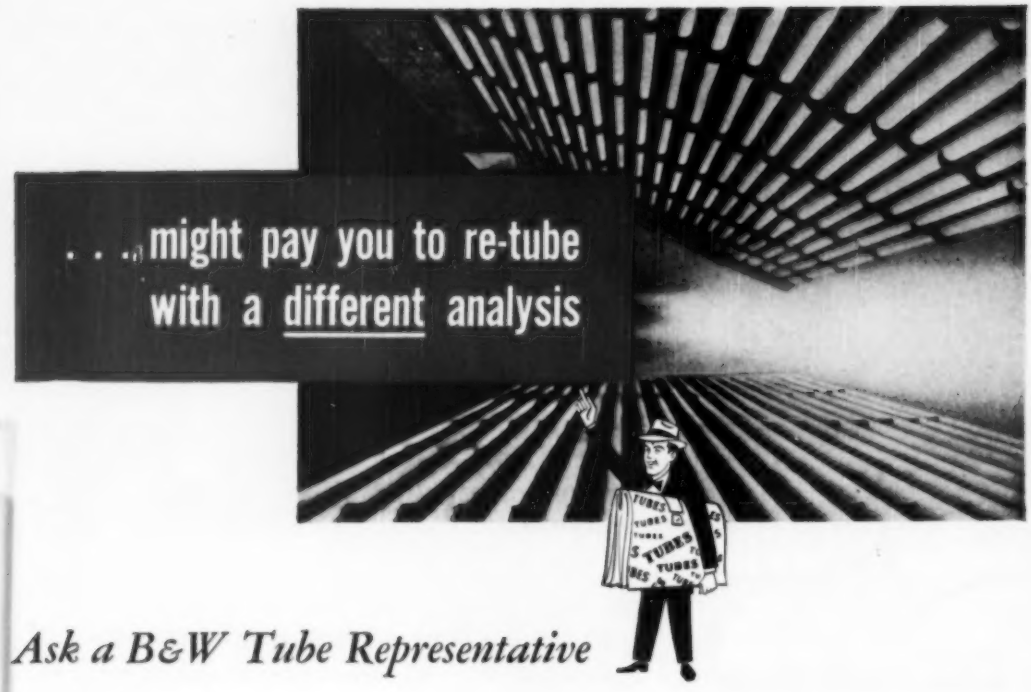
Refiners . . . both major and independent . . . from coast to coast are intensely interested in Platforming, and it may be the *one process* that will *permanently* solve your problem.

UNIVERSAL OIL PRODUCTS COMPANY

UOP

General Offices: 310 S. MICHIGAN AVENUE, CHICAGO 4, ILL., U.S.A.
LABORATORIES: RIVERSIDE, ILLINOIS

Universal Service Protects Your Refinery



Ask a B&W Tube Representative

B&W REFINERY TUBING

. . . a wide choice of service-proved analyses* to meet *all* conditions of pressure, temperature, corrosion and oxidation.

Carbon Steel	
Carbon Moly Steel	(½% Mo)
Croloy ½	(½% Cr, ½% Mo)
Croloy 1¼	(1¼% Cr, ½% Mo)
Croloy 2	(2% Cr, ½% Mo)
Croloy 2¼	(2¼% Cr, 1% Mo)
Croloy 3-M	(3% Cr, 1% Mo)
Croloy 5	(5% Cr, ½% Mo)
Croloy 5-Si	(5% Cr, ½% Mo, 1½% Si)
Croloy 5-Ti	(5% Cr, ½% Mo, ½% Ti)
Croloy 7	(7% Cr, ½% Mo)
Croloy 9-M	(9% Cr, 1% Mo)
Croloy 18-8-S	(18% Cr, 8% Ni)
Croloy 16-13-3	(16% Cr, 13% Ni, 3% Mo)
Croloy 25-20	(25% Cr, 20% Ni)

*The above list indicates only the more popular B&W Tubing Steels for Refinery Service and does *not* constitute the complete range of grades in which B&W Tubing is produced.

Today's diversity of petroleum processing operations imposes a greater variety of requirements than ever before on alloy and stainless refinery tubing . . . makes proper selection of analyses increasingly difficult. Your B&W Tube Representative may be able to show you . . .

FOR EXAMPLE

. . . how, in a given service, re-tubing with certain lower grades can give savings in initial cost without materially affecting performance; or how, under different conditions, switching to a higher alloy can pay service dividends far beyond a negligible increase in cost. Consult *your* B&W Tube Representative—his factory training in cost-saving "tube technics" and broad knowledge of refinery applications can help you decide whether you are expecting too *much* . . . or too *little* . . . from your present tubing.

B&W SEAMLESS and WELDED TUBES

THE BABCOCK & WILCOX TUBE COMPANY

General Offices: Beaver Falls, Pa.

Plants: Alliance, Ohio, and Beaver Falls, Pa.

Sales Offices: Alliance, Ohio • Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill. • Cleveland 14, Ohio • Denver 2, Colo. • Detroit 26, Mich. • Houston 2, Texas • Los Angeles 15, Calif. • New York 16, N. Y. • Philadelphia 2, Pa. • St. Louis 1, Mo. • San Francisco 3, Calif. • Syracuse 2, N. Y. • Toronto, Ontario • Tulsa 3, Okla. • Vancouver, British Columbia

TA-1578-S

Dependable Selectivity...

Efficient H_2S removal in the presence of CO_2

Dependable, low-cost removal of H_2S in the presence of large volumes of CO_2 is a primary advantage of the Shell Phosphate Process. All but harmless amounts of H_2S are removed while most of the CO_2 is left untouched.

Important too is the fact that the treating process has no harmful effect upon subsequent processing operations. The treating agent is inorganic . . . non-contaminating to hydrocarbons.

Low operating costs are the rule with the Shell Phosphate Process. Since a minimum of CO_2 is removed, steam regeneration of the treating solution costs less. Also, because the regenerated H_2S is in a relatively high concentration, the cost of conversion to solid sulphur or sulphuric acid is greatly reduced.

The Shell Phosphate Process is available to any operator under license from the Shell Development Company . . . together with experienced engineering service for its design, installation, and operation.

SHELL

SHELL DEVELOPMENT COMPANY

50 West 50th Street, New York 20, N. Y.

NOW! AT NO INCREASE IN COST TO YOU

Makes a good steam trap better

Nearly 650,000 Yarway Impulse Steam Traps have already been installed—proof that they are doing a good job.

Now a *stainless steel* body makes this famous little trap even *better—at no increase in cost.*

Better in *wear*, better in *service*. Users will find Yarways require less maintenance than ever. All parts are wear-resistant, practically wear-proof. There is only one moving part, a small, stainless steel, heat-treated valve. Important, too—Yarway Impulse Traps are *suitable for all pressures up to specified maximum without change of valve or seat.*

Other popular advantages are *small size, light weight, easy installation* and *low cost.* Often it costs *less* to buy a new Yarway trap than to repair an old, ordinary trap.

In performance—ask any user. They all say Yarways are the traps that *get equipment hotter sooner and keep it hot!*

For better steam trap performance, try *new* stainless steel Yarways.

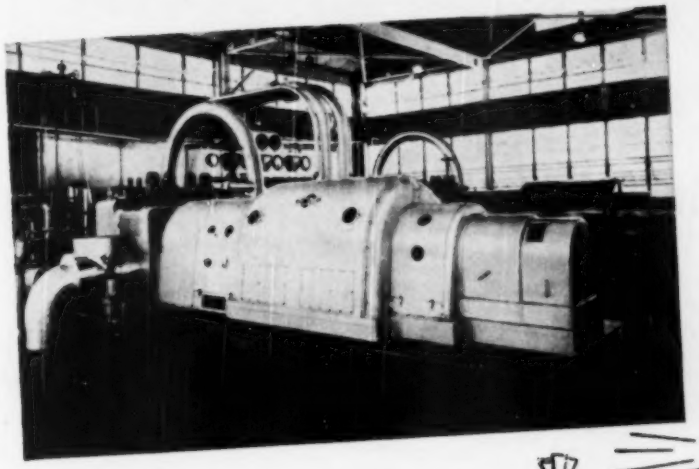
YARWAY IMPULSE STEAM TRAPS ARE SOLD BY OVER 200 DISTRIBUTORS. THERE IS ONE NEAR YOU.

Write for name and address.

YARNALL-WARING COMPANY
128 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY IMPULSE STEAM TRAP

HANDLING TWO JOBS AT ONCE...



and saving money on both!

Two 1500 KW Worthington turbine-generators, installed in the Eunice, N. M. plant of the El Paso Natural Gas Company. These are non-condensing extraction turbines designed to operate on initial steam conditions of 575# — 575° FTT exhausting at 5#G back pressure.

Worthington Turbine-Generators Selected By Natural Gas Firm For Both Power and Product-Conditioning

Pumping natural gas from southeastern New Mexico and the Texas Panhandle to points in California and Arizona, the El Paso Natural Gas Company uses Worthington Turbine-Generators for double duty Besides furnishing electricity for the company's plant in Eunice, N. M., the turbines automatically extract steam at 125#G for heating Amine solution, which is mixed with the gas to remove impurities.

In every branch of industry, users are getting daily proof of the outstanding flexibility of Worthington Turbine-Generator Sets — not only as sources of more dependable, more economical electric power, but as cost-cutting suppliers of processing steam for many important allied purposes.

WORTHINGTON TAKES ALL THE RESPONSIBILITY

Worthington builds Turbine-Generator Sets in sizes up to 10,000 kw, and in all types. Each is designed to make steam do more work, and each is backed by Worthington's undivided responsibility for the complete unit's design, assembly and performance. For expert aid in selecting the *right* size and type for your own requirements . . and further proof that *there's more worth in Worthington* . . call our nearest District Office. Or write to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N. Y.*

WORTHINGTON

STEAM TURBINES

T.O.9

A GREAT TEAM IN STEAM

Feed Water Heaters | Multi-Stage Turbines | Boiler Feed Pumps | Turbine-Generator Sets | Single-Stage Turbines | Surface Condensers

H_3BO_3
HCl
$C_2H_4O_2$
C_6H_6
H_2S
C_6H_6
NH_4OH
$C_4H_3O.CH_2OH$
NH_3
HNO_3
NH_4OH
SO_2
C_6H_7N
$H_4P_2O_6$
C_2H_4
H_2SO_4
$C_{14}H_{10}$
$(NH_4)_2S$
C_2H_4
C_3H_6O
S
$C_{14}H_{10}$
NH_4F
CH_3COOH
NH_4Cl
Non-Corrosive Cooling Towers
More Vital Than You May Think
Even if the water to be cooled contains no traces of any corrosive chemical, though it often does, the air near the tower may bear corrosive fumes, emanating from your plant or from another plant adjacent to yours. These fumes drawn through the tower and mixing with the falling water can have a destructive effect on fans and interior hardware of water cooling towers. That's why fan blades for large and medium size C. H. Wheeler towers are made of non-corrosive plastic; also why bolts, nuts and nails may be supplied in either brass, copper, or standard galvanized steel. Tests and long successful experience of users have proved these plastic fans are immune to the attack of dilute solutions or fumes of the chemical compounds indicated by these formulae, and many others. Of course, the interiors of all C. H. W. towers are made of redwood, obviously non-corrosive, and the casings are of redwood, asbestos cement board, masonry, brick or properly painted steel. . . . Plastic fans and C. H. Wheeler water cooling towers have numerous other superiorities, fully described in descriptive literature. Write for it.
C. H. WHEELER MANUFACTURING CO.
1818 Sedgley Avenue, Philadelphia 32, Pa.
REPRESENTATIVES IN MOST PRINCIPAL CITIES
SINCE 1903
C.H. Wheeler
STEAM CONDENSERS • WATER COOLING TOWERS
EJECTORS • STEAM JET VACUUM REFRIGERATION
OF PHILADELPHIA

Ladish Elbows

...A Complete Size Range Another Reason to Specify *Controlled Quality*

SEAMLESS WELDING FITTINGS

From the small fitting that weighs several ounces to the half-ton giant . . . whatever your fittings requirement, the Ladish line provides you with an unrestricted choice of sizes in a complete range of types, weights and materials. In addition, every fitting offers the added dependability assured by the high manufacturing and metallurgical standards of Ladish Controlled Quality.

THE COMPLETE FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

LADISH CO.

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

DISTRICT OFFICES: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago
St. Paul • St. Louis • Atlanta • Houston • Los Angeles • Havana

13 in '49

THE *La Gloria*

CASINGHEAD GAS PLANT

One of the 13 plants completed by HUDSON in '49.

Of these 13 major projects, 8 were for clients for whom HUDSON had previously engineered and constructed complete plants . . . good evidence of the satisfaction of owners and operators of HUDSON built plants.

The casinghead plant pictured is the latest of six projects completed for La Gloria Corporation over the last 10 years.

From Colorado to Alabama and abroad, at elevations from sea level to a mile, at atmospheric temperatures of minus 40° F. to plus 110° F., under process pressures from high vacuum to 8000 pounds per square inch, HUDSON plants have built the HUDSON reputation for dependability and performance.

HUDSON

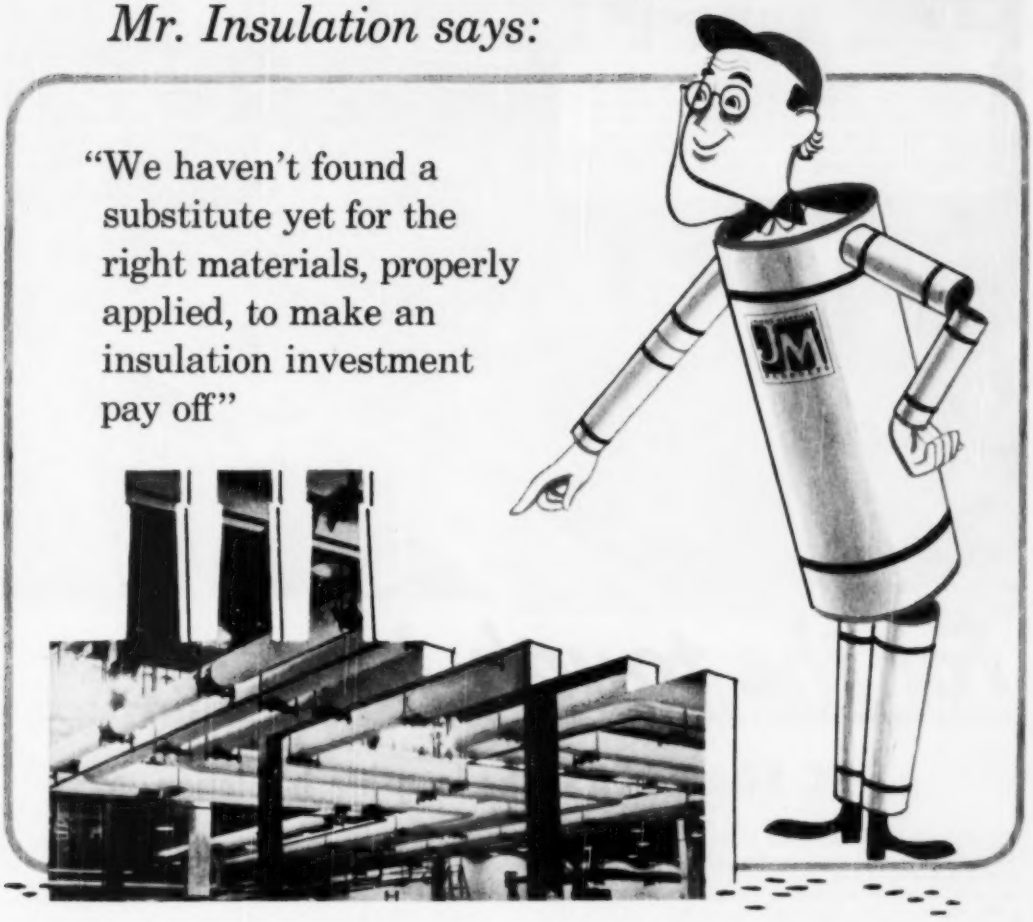
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

GAS COMPRESSOR STATIONS — CYCLING PLANTS — GAS DEHYDRATION PLANTS — NATURAL GASOLINE PLANTS — FRACTIONATION UNITS — CRUDE TOPPING UNITS — PRESSURE MAINTENANCE PLANTS — HYDROGEN SULPHIDE REMOVAL PLANTS — ATMOSPHERIC AND VACUUM DISTILLATION UNITS

Mr. Insulation says:

"We haven't found a substitute yet for the right materials, properly applied, to make an insulation investment pay off"



To be successful an insulation job must be properly engineered. In addition, it must have these two important ingredients:

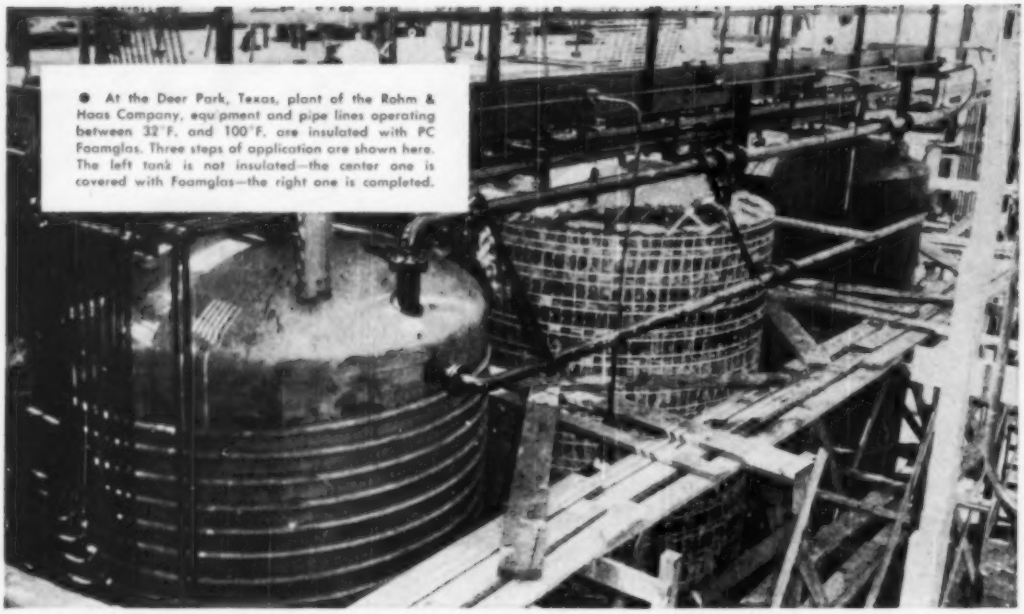
1... THE RIGHT MATERIALS: service conditions vary greatly in industrial applications. That's why no one insulation can serve as a jack-of-all-trades on all jobs. For this reason, Johns-Manville uses asbestos and many other selected raw materials to produce the most complete line of insulations available. These insulations serve applications ranging between the extreme temperatures of 400F below zero to 3000F above.

2... THE RIGHT APPLICATION: Here again Johns-Manville's long experience in the field of insulation can be of value to you. Insulation engineering advice plus the services of insulation contractors trained in Johns-Manville methods of correct application are at your call.

If you are planning an insulation job why not put your problem up to insulation headquarters? Write Johns-Manville, Box 290, New York 16, N. Y.

JM

Johns-Manville *first in* **INSULATIONS**



● At the Deer Park, Texas, plant of the Rohm & Haas Company, equipment and pipe lines operating between 32°F. and 100°F. are insulated with PC Foamglas. Three steps of application are shown here. The left tank is not insulated—the center one is covered with Foamglas—the right one is completed.

For the tough jobs—

PC FOAMGLAS—the long life insulation

PLANT managers have found, in PC Foamglas, the solution to many of their most pressing insulating problems. The unique properties of Foamglas make it the ideal insulating material for indoor and outdoor piping, tanks, towers and other processing equipment. This unique material has proved its ability to meet exacting standards of insulating efficiency and to keep insulating costs low.

The cellular glass structure of Foamglas makes it an exceptionally effective insulation. And, being glass, it has unusually high resistance to moisture, vapor, acid atmospheres and other destructive elements. It is noncombustible, odorless and vermin-proof. Freedom from repairs, maintenance and replacement makes Foamglas a truly economical insulation. When properly installed, Foamglas *retains* its original insulating efficiency.

Foamglas is light in weight, rigid and strong. Being friable when subjected to point loading, it yields readily to surface irregularities, such as rivet heads and welds, thus can be pressed close to areas to be insulated without breaking or cracking. Foamglas comes in flat blocks, curved segments and beveled lags for processing equipment, and in preformed sections for standard piping. Fitting covers can be had from the factory or can be cut and formed in the field with ordinary tools.

When you are figuring on insulation, make sure you have the latest information on PC Foamglas. You will find it in our recently published booklet, which contains descriptive text and photos of recent jobs, charts, tables, up-to-date specifications and installation instructions. Just send in the coupon and you will receive a sample of Foamglas and your copy of our literature.

This is FOAMGLAS®

The entire strong, rigid block is composed of millions of sealed glass bubbles. They form a continuous structure which has unusually high resistance to moisture, vapor and acid atmospheres, is noncombustible, verminproof and odorless. In those closed glass cells, which contain still air, lies the secret of the material's long life insulating efficiency.

Pittsburgh Corning Corporation
Dept. T-90, 307 Fourth Avenue
Pittsburgh 22, Pa.

Please send me, without obligation, a sample of PC Foamglas and your free booklet on industrial insulation.

Name .....

Address .....

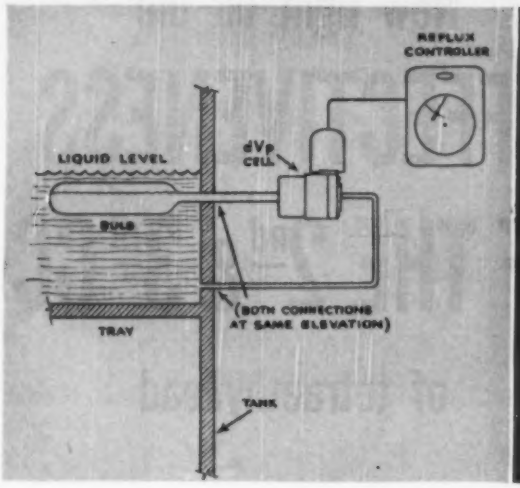
City ..... State .....

PITTSBURGH PC CORNING

FOAMGLAS INSULATION

. . . when you insulate with FOAMGLAS . . . the insulation lasts!

For the first time!



CONTINUOUS CONTROL OF VAPOR PRESSURE

with the new, exclusive Foxboro dVp Cell

This revolutionary development by Foxboro introduces new simplification in distillation processes. Automatically measuring and transmitting vapor pressure *differential*, it eliminates time-consuming laboratory analyses in fractionating tower operation . . . permits tapping off fractions of any desired vapor pressure, within precise tolerances, continuously and automatically.

In the dVp Cell, the vapor pressure at any specified point in the column is continuously compared with the vapor pressure of a sample of the material desired at that point. The sample is contained in a bulb immersed in the liquid. The dVp Cell measures the difference between the two vapor pressures and transmits this difference to an automatic controller on the process. Changes in temperature affect product and sample equally, and hence have no effect on the differential measurement.

Detecting small pressure differences accurately, the new dVp Cell is not injured by high unbalanced pressures. It uses no mercury, is compact and easy to install. Self-contained manifold permits quick, easy filling of sample bulb with the reference fluid without special equipment, and without disassembly of the cell.

Write for detailed information on this unique new Foxboro development. Inquiries concerning unusual or experimental applications especially invited. **The Foxboro Company, 74 Neponset Ave., Foxboro, Mass., U. S. A.**

FOXBORO
REG. U. S. PAT. OFF.

RECORDING · CONTROLLING · INDICATING
INSTRUMENTS

New light on the EFFECTIVENESS OF THE 2nd & 3rd CC

of tetraethyllead

In measuring the relative effectiveness of the 1st, 2nd and 3rd cc of tetraethyllead when added to a base fuel, it is common practice to use the resulting increase in octane number as the measuring stick. However, this is not completely realistic.

A better yardstick is the relative increase in compression ratio made possible by the additions of tetraethyllead.

The octane scale does not give a direct indication of the performance of fuels in an engine. Units in this scale appear to be equal in size to every other unit. But actually, in terms of engine performance, octane units at different levels vary greatly in size. Chart 1 (lower left) shows how the octane units get bigger and bigger going up the scale.

The usual way of looking at tetraethyllead

CHART 1

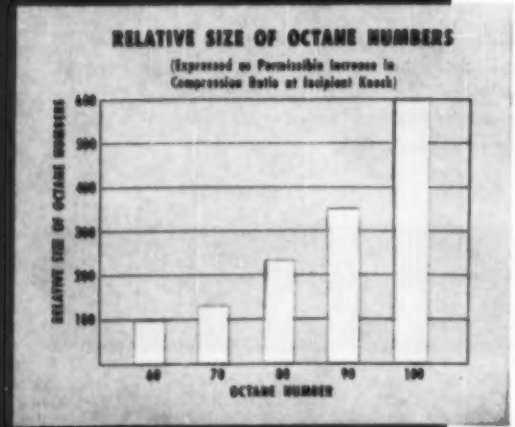


Chart 1. This chart shows that the units going up the octane scale become larger and larger in terms of permissible increase in compression ratio.

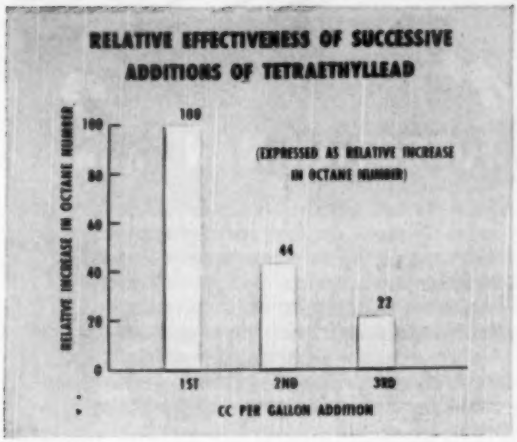


CHART 2

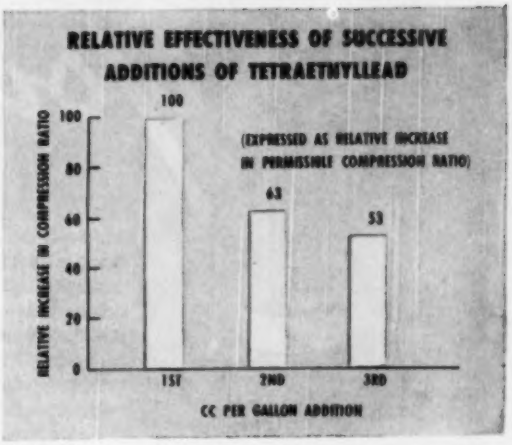


CHART 3

effectiveness is illustrated in Chart 2. This shows the average relative increase in octane numbers due to the addition of 1, 2 and 3 cc of tetraethyllead to twenty current base stocks. (The effectiveness of the 1st cc is considered to be 100%.) In terms of octane numbers, there appears to be a marked tapering off in effectiveness with increase in concentration, to 44% for the 2nd cc and to 22% for the 3rd cc.

On the basis of engine performance, this diminishing unit effectiveness of tetraethyllead with increased concentration becomes much less. Consider the effectiveness of tetraethyllead concentrations from the standpoint of increases in compression ratio made possible in cars on the road (Chart 3). On this basis the 2nd cc is 63% as effective as the 1st, while the 3rd cc is 53% as effective. Thus *the 3rd cc is 84% as effective as the 2nd cc.*

Refiners interested in providing the highest measure of antiknock performance on the road for each dollar of refining cost often obtain substantial economic benefits from periodic re-evaluation of the use of larger amounts of tetraethyllead per gallon. Ethyl technologists gladly assist refiners in their efforts to obtain the best fuel performance for each dollar invested in "Ethyl" antiknock compound.

Previous messages in this series, available on request, have discussed the limitations of the octane scale in the evaluation of the contribution to antiknock quality made by tetraethyllead and have suggested more realistic scales of measurement. Future messages will deal with other benefits contributed to fuels by tetraethyllead.

Over 400 specialists working full time on fuel and engine developments

ETHYL CORPORATION
RESEARCH LABORATORIES

DETROIT, MICHIGAN
1600 West Eight Mile Road

SAN BERNARDINO, CALIFORNIA
2600 Cajon Road

IS THE TANK GAUGER

Your FORGOTTEN MAN . . . ?

Is your tank gauger still climbing tank stairs and ladders, in daylight and darkness, in all kinds of weather, to gauge tank contents with a tape and bob? Do you permit him to open a gauge hatch and expose himself to noxious and sometimes lethal fumes and vapors while manually gauging a tank and recording a reading greatly influenced in accuracy by the human element? Are you willing to assume the unnecessary hazards of explosions and damage to tank tops by having a gauger do a job the hard way, when it can be done a thousand times faster, infinitely more safely, and with far greater consistency and accuracy with S. & J. Remote Reading Electronic Gauges?

Shouldn't the same standards of safety, efficiency and accuracy demanded in other refinery operations be equally applicable to tank gauging? Of course they should! That's why S. & J. has designed an electronic system of tank gauging that is almost instantaneous, efficient, eliminates all hazards, and depends for accuracy only on the ability of an individual to read a dial and record the reading under conditions of adequate visibility in the pump house. It's tomorrow's STANDARD—ready for you TODAY.

The Brown ELECTRONIK, widely used in the petroleum industry, is the electronic component of the S. & J. Remote Reading Electronic Gauging System. It's an instrument that is well known and understood by the personnel involved.

With the S. & J. System, you flip a switch and the feet and inches of tank measurement, as well as the temperature, if you like, appear on the dial before you—QUICKLY, SAFELY, ACCURATELY.

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ACCURACY

not for its own sake but because it

Reduces your Piping Costs

Exceptional dimensional accuracy and uniformity of Midwest Welding Fittings speeds piping work and reduces cost. All pipe can be cut in advance according to drawings, with assurance of accurate fit. Welders do not have to spend costly time struggling to line up fittings and pipe. Welding proceeds rapidly, economically with no time-wasting compensation for inaccuracies.

All critical dimensions of Midwest Fittings are accurate and uniform. For example, Midwest Welding Elbows are first made slightly oversize. They are then reheated to forging temperature and brought to final size in compression dies. In addition to relieving stresses from forming and welding, this assures true circular cross-section, controlled wall thickness and accurate radius, included arc and tangents. Midwest Elbows and Tees have accurate welding bevels, included angles, etc., because all ends are machined simultaneously in special machines.

There is a Midwest Distributor near you. Get in touch with him for your fitting needs. Also ask for Catalog 48.

4098

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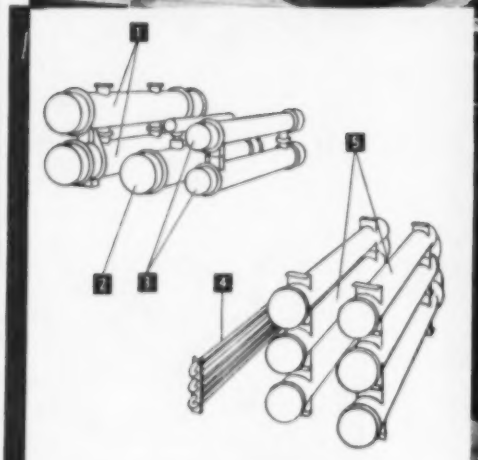
MIDWEST WELDING FITTINGS Improve Piping Designs and Reduce Costs



IN THIS G-R INSTALLATION

1. 2 Type PST Tubular Residuum Stripping Column Condensers
2. Type BLVB Tubular Fractionating Column Vapor Exchanger
3. 3 Type PST Crude Column Condensers
4. 3 Twin G-Fin Sections Serving as Gland Seal Gas Oil Coolers
5. 6 G-Fin Polysections serving as Crude-to-Residuum Exchangers

GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

Meet this G-R family group of HEAT TRANSFER APPARATUS

In the illustration on the adjoining page, you will find some of the large family of G-R heat transfer apparatus. This particular group includes finned tube and bare tube units . . . condensers, heat exchangers, and coolers.

Many additional G-R units, not shown in the illustration, and including condensers, heaters, coolers, subcoolers, reboilers, and heat exchangers on a great variety of services were also furnished for this representative plant.

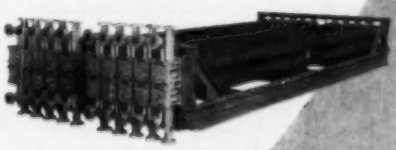
Throughout the petroleum industry in the United States and abroad, in refineries, natural gas and gasoline plants, and in pipe line pumping stations, G-R heat transfer apparatus has made records of effectiveness, economy, and durability on standard and special services. To assure best results in your heat transfer operations, standardize on G-R apparatus.

THE GRISCOM-RUSSELL CO.
285 Madison Avenue, New York 17, N. Y.

SOME STANDARD DESIGNS OF G-R HEAT EXCHANGERS

G-R Twin G-Fin Section — with finned type heat transfer elements that compensate for the unequal heat transfer rates of fluids of high and low heat conductivity.

G-R Tubular Exchanger—with several distinctive features that provide most effective heat transfer and minimum maintenance expense.



G-R Tubeflo Section—the only design of heat transfer apparatus that maintains rated capacity with clogging or dirty fluids.

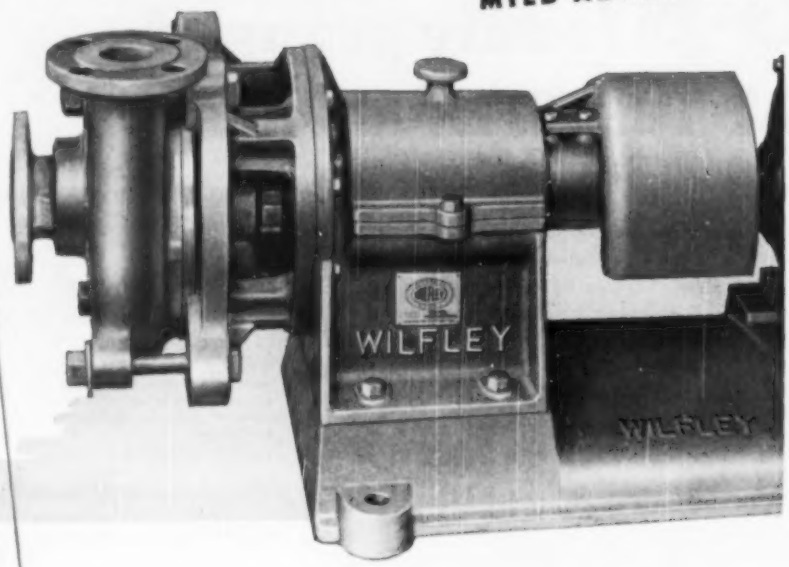
GRISCOM-RUSSELL

NEW MODEL

AF

WILFLEY

FOR ACIDS
CORROSIVES
HOT LIQUIDS
MILD ABRASIVES



WILFLEY Acid Pumps are on the job in modern chemical plants all over the world. Every day, they move hard-to-handle acids, corrosives, hot liquids and mild abrasives on a trouble-free, 'round-the-clock schedule. Actual production-line records show substantial dollar savings in stepped-up performance and low-cost operation.

Efficient, dependable WILFLEY Acid Pumps are available in 10- to 2,000-G.P.M. capacities; 15- to 150-ft. heads and higher. Individual engineering on every application. *Write or wire for detailed information.*

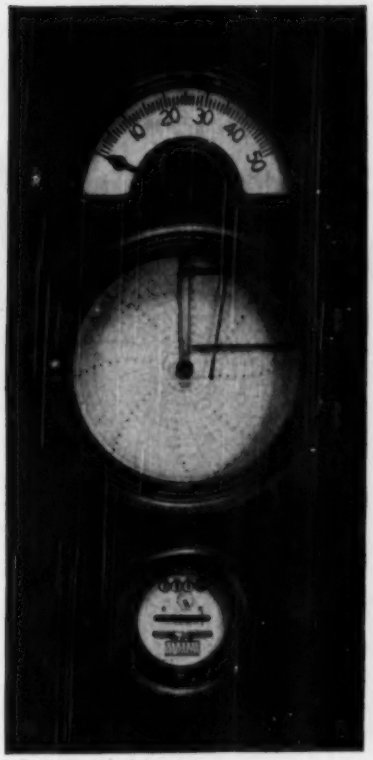
Buy **WILFLEY** *for cost-saving performance*

A. R. WILFLEY & SONS, INC., DENVER, COLORADO, U.S.A.

New York Office: 1775 Broadway, New York City

WILFLEY *Acid* PUMPS

Integrator



Indicator-Recorder-Integrator

Varying flows are accurately totalized because the integrator is continuous

The Republic flow integrator, being of the modified watt-hour type, totalizes continuously—not intermittently. It operates independently of the recorder and its accuracy is not dependent on or affected by any clock mechanism or mechanical action.

The Republic meter is, on this account, peculiarly fitted to follow all changes in flow rate and accurately measure highly fluctuating flows.

ALL TYPES OF FLUIDS

Republic electric type flow meters are available for measuring the flow of all types of liquids and gases. Meter bodies are built for metering fluids at line pressures up to 5,000 lb. per sq. in. and for all ranges of differential pressure. The reading instruments—indicator, recorder and integrator—are of the remote reading type and can be located any distance from the point of flow measurement.

ANY COMBINATION

While each Republic reading instrument is standard in design and construction each is especially calibrated for the particular flow measurement for which it is specified. Any reading instrument, indicator, recorder or integrator, may be obtained separately or in any combination desired, making possible the highest degree of flexibility in plant use.

SIMPLE IN OPERATION

The Republic electric meter is the only flow meter commercially manufactured which is strictly electric in its operation. All other types of so called electric meters use the motion of the mercury to move a float or produce a force which is then converted into an electrical value which is in turn transmitted to a receiving or reading instrument. In the Republic meter, the transmitted electrical value is determined directly by the mercury motion, thus eliminating one of the steps in the sequence, and simplifying the mechanism to that extent. There are no floats, levers, cams, rotating shafts or anything else to interfere with the unimpeded movement of the mercury, which has no work to perform, but merely fulfills the function of making contact.

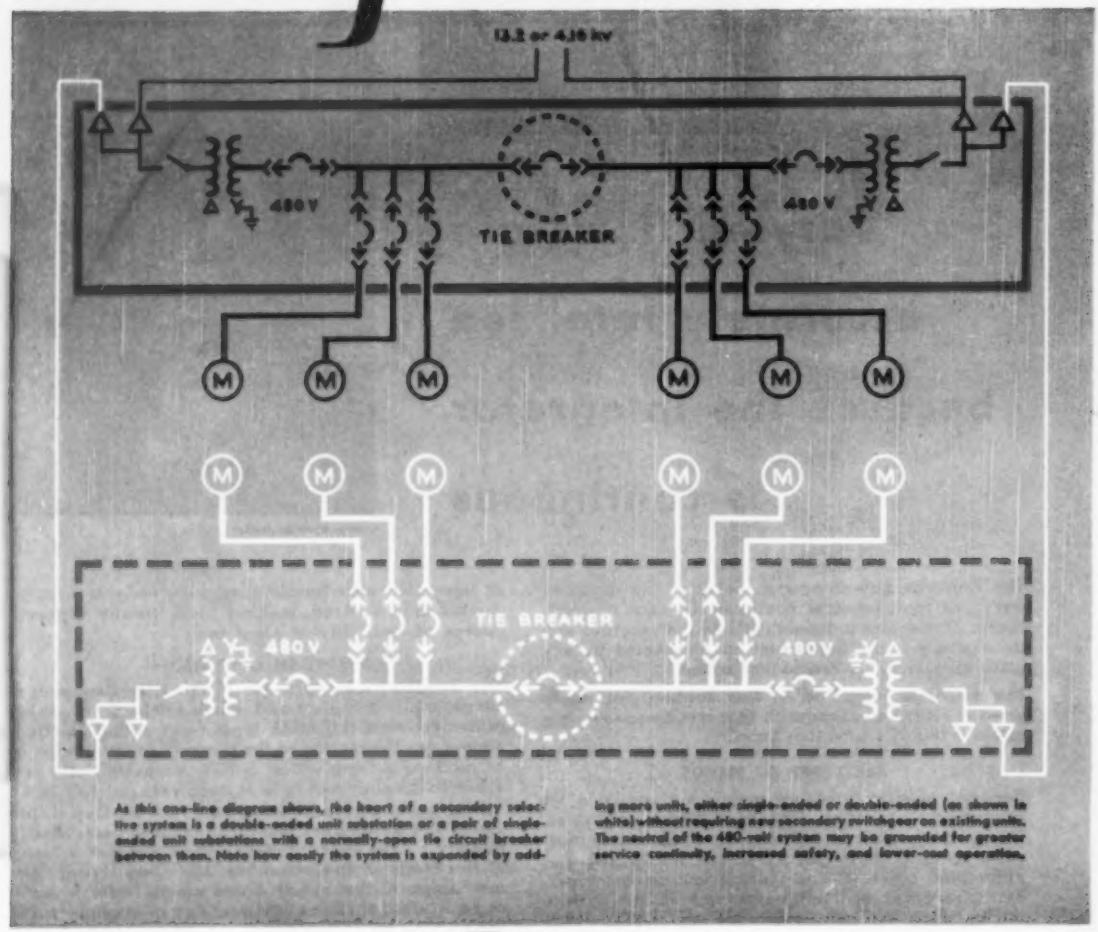
NEW DATA BOOK

Just off the press—a completely new data book describing and illustrating, in detail, the operating features of the Republic Flow Meter and its many applications. Write for your copy of Data Book No. 702—there is no obligation.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

What's the trend in refinery electrification?

secondary



As this one-line diagram shows, the heart of a secondary selective system is a double-ended unit substation or a pair of single-ended unit substations with a normally-open tie circuit breaker between them. Note how easily the system is expanded by adding more units, either single-ended or double-ended (as shown in white) without requiring new secondary switchgear on existing units. The neutral of the 480-volt system may be grounded for greater service continuity, increased safety, and lower-cost operation.

Here's what you need to modernize your power system!

WHEN YOU COME TO GENERAL ELECTRIC you get far more than the finest in electrical equipment. A General Electric application engineer, familiar with refinery practices, is at your disposal. If desired, he stands ready to assist you in co-ordinating all the needed components, engineering your power distribution into one modern, efficient system.

selective distribution systems

WITH UNIT SUBSTATIONS

—to protect continuity of service at minimum cost

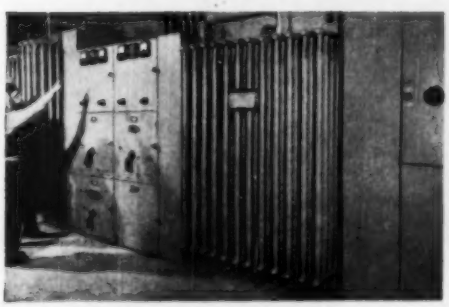
What's behind the growing refinery practice of distributing power through secondary selective systems? Primarily it's recognition of the fact that for most plants it provides a simple, low-cost way to safeguard service continuity for operations requiring uninterrupted production.

This method utilizes a normally-open tie circuit breaker between the secondaries of two transformers in a double-ended unit substation. The tie provides an alternate source of power for secondary circuits if either transformer becomes de-energized by a fault in the primary circuit. In effect, it enables one "partner" when necessary to carry the essential load.

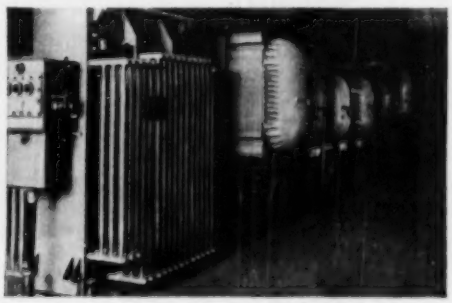
Simplicity is another advantage of this system. Operating personnel need no special training to operate and maintain the equipment contained in a double-ended unit substation—chiefly transformers and manually-operated drawout air circuit breakers.

Moreover, expansion is easy and economical. Single-ended or double-ended substations can be added at will. Since no added interrupting duty is imposed, no new secondary switchgear is needed on existing units. Full data is contained in Bulletin GET-1438, "Secondary Networks for Industrial Plants." Send for your copy today. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

TO HELP CUT YOUR POWER DISTRIBUTION COSTS . . . Don't miss seeing the "More Power to America" full color and sound slide-film "Modern Industrial Power Distribution." It's packed with helpful, cost-cutting ideas you can use. Ask your G-E representative to arrange a showing for your organization.



G-E double-ended load-center unit substations for non-hazardous areas are compact, factory-assembled "packages." Shipped ready to install, they are furnished in flexible combinations of incoming-line and secondary-circuit arrangements with transformers from 100 to 2000 kva.



For semi-hazardous areas, G-E double-ended load-center unit substations have easily removable air circuit breakers, each in Class I, Group D enclosures, plus primary power circuit breaker, a standard Pyranol (R) transformer section, and a secondary bus enclosure.

GENERAL ELECTRIC

GEI-12

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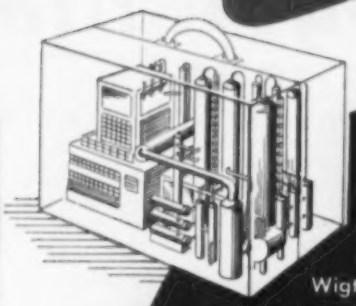
IN PLANT
CONSTRUCTION...

"PACKAGED PLANT CONSTRUCTION"
A Complete Service from PLANNING to PRODUCTION



It is a service by Wigton-Abbott Corporation that broadens the definition of plant construction to include creation of the process, designing and installation of equipment, and "delivers" the complete plant, ready for operation. To perform and to coordinate these complex functions, Wigton-Abbott Corporation employs the experience and skill of engineers and architects—including specialists in all branches of chemical, mechanical, electrical, civil and industrial engineering. The Construction Department is staffed and equipped to erect any type of industrial plant. A Wigton-Abbott Corporation representative will be glad to consult with you on any phase of plant design and construction.

Yours for the asking...

Reading time, only 10 minutes—but it will save you many hours by answering basic questions.

Wigton-Abbott Corporation

DESIGNERS...ENGINEERS...CONTRACTORS...PLAINFIELD, NEW JERSEY

The exteriors may look alike— but *what a difference inside!*

Inside one home, life goes on smoothly and harmoniously. But in the house next door there's constant friction and nerve-wearing turmoil.

Compare the outside appearance of any standard Powell valve with that of any other valve of the same type and size. You will probably notice very little difference. But inside—that's another story.

There design, materials and manufacturing skills make the difference between a Powell Valve—built to operate smoothly and efficiently over a long period of time—and a valve that will have only a short life before it requires maintenance or even replacement.

Powell also makes many *exclusive* patterns to meet the requirements of special services. In these, too, long trouble-free performance is a primary consideration.

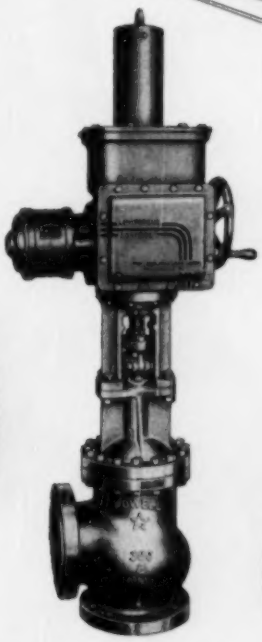


Fig. 3063—Class 300-pound Cast Alloy Steel Angle Valve. Streamlined areas through the body assure maximum flow with minimum pressure drop. Adapted for high temperatures—up to 1400 F. Top-mounted electric motor operator.

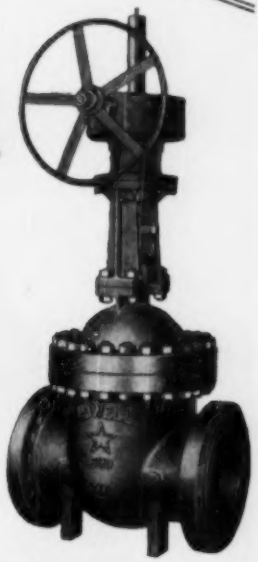


Fig. 6079—Class 600-pound Cast Steel Gate Valve for Pipe Line Service. Bevel gear operation. Can also be furnished with motor operator. Classes 150, 300 and 400-pound valves also available.

Fig. 559—125-pound Iron Body Bronze Mounted Swing Check Valve with flanged ends, bolted flanged cap and regrindable, renewable bronze seat and disc. Disc when wide open, permits full, unobstructed flow through the valve body. →

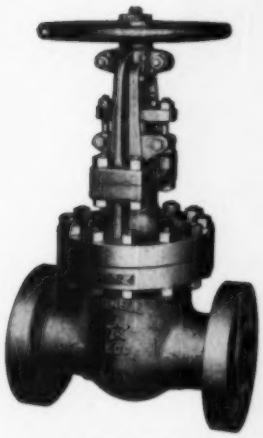


Fig. 6003—Class 600-pound Cast Steel Gate Valve. Flanged ends, outside screw rising stem, bolted flanged yoke, tapered solid wedge.

Fig. 1375—200-pound Bronze Gate Valve with screwed ends, inside screw rising stem, union bonnet and renewable wear-resisting "Powellium" nickel-bronze seat rings and disc.

The Complete Powell Line includes Globe, Angle, "Y", Gate, Check, Non-return, Relief, and Flush Bottom Tank Valves in Bronze, Iron, Steel and a wide range of Corrosion-resistant metals and alloys.

Ask your nearest Distributor—or write direct

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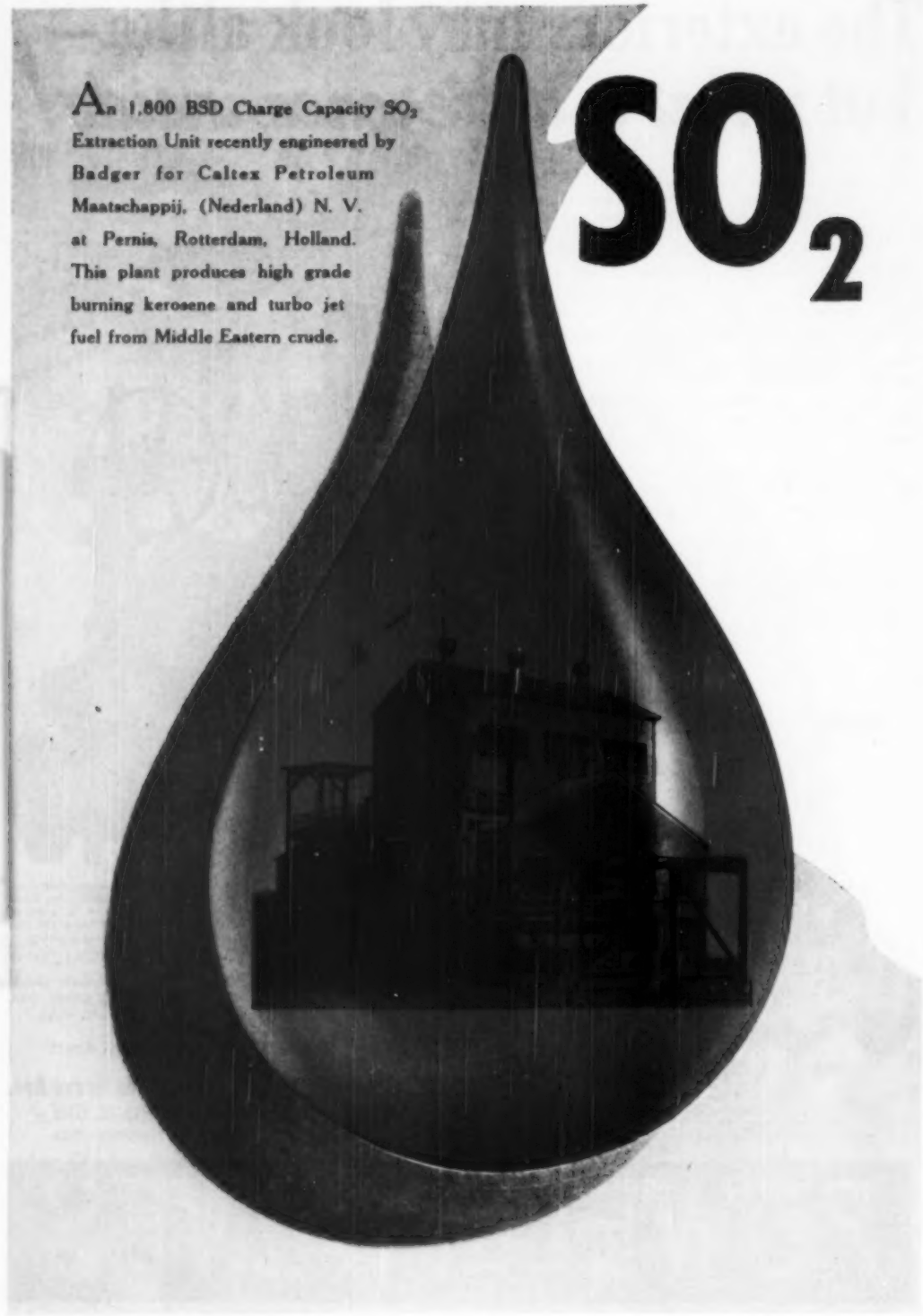
DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES


An 1,800 BSD Charge Capacity SO_2 Extraction Unit recently engineered by Badger for Caltex Petroleum Maatschappij, (Nederland) N. V. at Pernis, Rotterdam, Holland. This plant produces high grade burning kerosene and turbo jet fuel from Middle Eastern crude.
SO_2

Extraction

The Edeleanu Process has long been used for the production of high quality kerosenes from aromatic and high-sulfur crudes. For many years, Badger engineers have been expert in the utilization of the Edeleanu Process, and have applied extraction by SO_2 to the refining of a wide range of petroleum fractions. Uses include improved methods of producing pure aromatics, special solvents, transformer oils, clean burning furnace oils, and high cetane diesel fuels.

With the supply trend toward crudes of more difficult refining characteristics, industry is turning more and more towards SO_2 extraction. Badger's experience in the development and application of SO_2 extraction is proven by many Badger-built SO_2 units working successfully for refineries at home and abroad.

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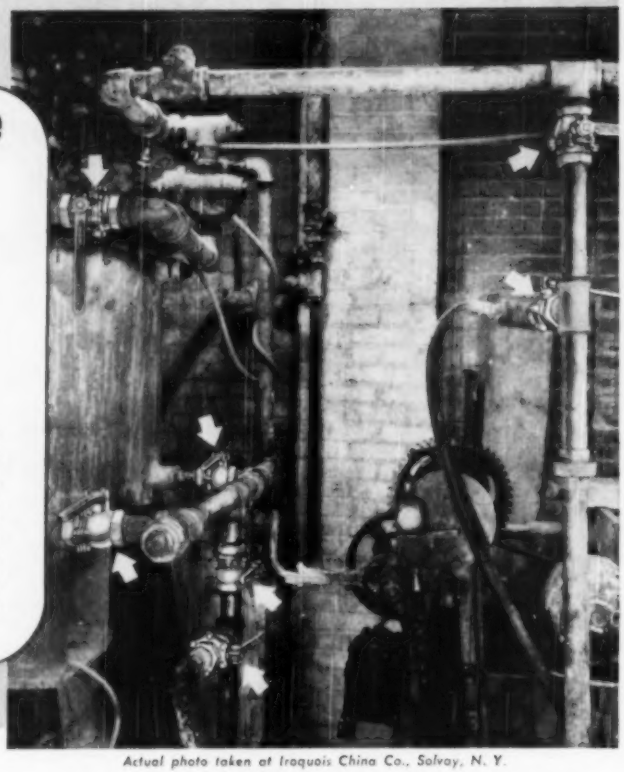
Process Engineers and Constructors for the Petroleum, Chemical and Petro-Chemical Industries

Highly Abrasive Materials

are no threat to ROCKWOOD Ball VALVES

Foreman at Iroquois China Company, Solvay, New York, says "Rockwood Ball Valves are operated 40 times a day handling a mixture of clay and water. Each Valve has performed better, operated easier and lasted longer than any other valve we ever used."



Actual photo taken at Iroquois China Co., Solvay, N. Y.

- ***LEAK PROOF SERVICE • FULL ROUND FLOW***
- ***EASY TO OPERATE • NO MAINTENANCE***

The Rockwood Ball Valves shown in this picture are installed on a slip machine and lines. They are operated 40 times daily and handle a mixture of clay and water. This mixture, called "slip", is highly abrasive. Yet, under this severe condition, Rockwood Ball Valves have been in operation for over 14 months — longer than any other valves ever used — and during that time, have never required attention. Men using the Rockwood valves claim they operate easier and faster and a glance tells whether valves are opened or closed.

When using the conventional type valve, the Iroquois China Company found the turbulence created in the valve would add air to the "slip" and cause pin holes in the finished product. Also, the "slip" would accumulate in the bonnet and prevent full opening and tight closing. Rockwood Ball Valves eliminate this trouble. Rockwood Ball Valves are also successfully performing on glaze operations, where a mixture of ground glass and water is used.

The full *round* opening of the Rockwood Valves do not permit turbulence. Design of the resilient synthetic rubber seat in combination with the hard chromium floating ball makes Rockwood Ball Valves stay tight when closed.

A valve with these qualities will give top notch performance in your plant — why not install one today and be convinced.

Rockwood valves are recommended for 300 p.s.i. working pressure and are available in all pipe sizes from ½" to 4". They are today giving service in oil refineries, food, paper, textiles, chemical and rubber plants, etc.

Distributors in all principal cities.

ROCKWOOD SPRINKLER CO

102 HARLOW STREET WORCESTER 5, MASS

What do you look for when you buy chemicals?

No matter what you look for when you buy alkalies and associated chemicals . . . you'll find it when you *specify Solvay.*

In addition to price and specifications, Solvay offers the benefits of 69 years' experience with alkalies to assure you of finest quality. Solvay's five big plants, and more than 200 warehouse stock points from coast to coast guarantee prompt delivery.

For technical guidance, you can count on Solvay's "Industry-Wise" Technical Service—exclusive with Solvay—consisting of specialists who have a thorough knowledge of individual industries.

So why take less than the best? *Specify Solvay* and get all these advantages!

Top Quality

Exacting Specifications

Prompt Delivery

Right Price

Exclusive Technical Service

It pays to specify

SOLVAY

Soda Ash • Caustic Soda • Caustic Potash
Chlorine • Nytron • Potassium Carbonate • Calcium Chloride
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Sodium Nitrite • Ammonium Bicarbonate • Para-dichlorobenzene
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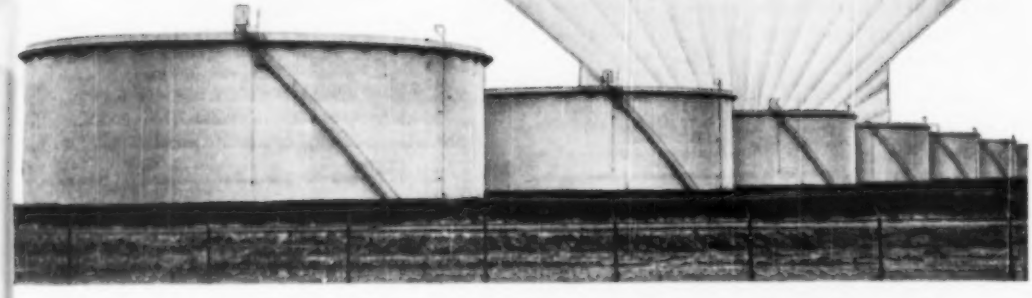
GRAVER FLOATING ROOF TANKS

at SHELL's WOOD RIVER TANK FARM



Serving the largest American crude oil pipe line ever built by private capital

To receive the river of crude oil flowing from the mighty Basin-Ozark pipe line system, Shell has completed the Southwest Tank Farm at its Wood River Refinery.

Sprawling over 190 acres of land, this tank farm has an aggregate capacity of approximately two and one-half million barrels, involving the use of 11 Graver Double Deck Floating Roof Tanks—140 feet in diameter, 48 feet high—each with a nominal capacity of 127,000 barrels.

Thus, Graver shares in the substantial progress of the Shell Oil Company in providing facilities for reducing operating expenses and achieving greater efficiency in the handling of crudes.

One of the 11 Graver Floating Roof Tanks at Wood River. All are Double Deck Construction with the fully effective *single* Graver Seal.

FABRICATED PLATE DIVISION

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

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GRAVER

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with 'PSC' Alloy Bubble Caps

Bubble caps made of the one alloy that best meets the coking and corrosion problems in your fractionating towers would, obviously, mean fewer cleanouts and less "down" time. The Pressed Steel Co. enables you to make such a selection, because we fabricate from the complete list of alloys. Records of PSC installations show that the resulting increase of "on-stream" hours often results in substantial long-run economies. In addition to being "alloy-right", PSC bubble caps benefit from our almost quarter-century of experience in fabricating welded-alloy refinery equipment and tubing.

Over 200 STANDARD STYLES of Caps and Risers, without Die Cost

With the dies on hand, we not only make prompt delivery but also save many customers the cost of dies. Special caps promptly designed. Send blue prints

New* LE JONS ASSEMBLY *Saves 7 Ways

Offering unprecedented simplicity, this new method of bubble cap assembly features: Faster assembly--no bolts or nuts, just hammer in wedges. Automatic alignment of caps. Tighter assembly. Stronger trays. Eliminates costly flaring or welding of risers. Less maintenance. Ease of cleanout or replacement.

Send for
BUBBLE CAP BULLETIN 21

The largest compilation of engineering data on bubble caps in printed form. Also drawings for use in determining methods of tray assembly. BULLETIN 31 describes LeJons assembly.

PSC EQUIPMENT IS "ALLOY RIGHT"

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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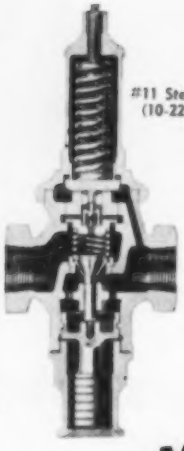
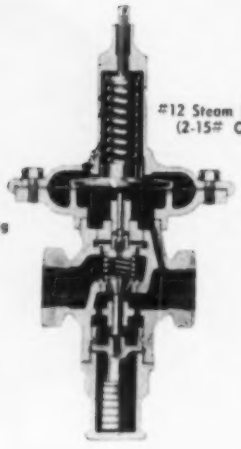
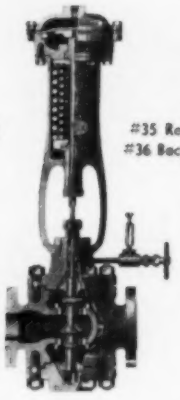


#11 Steam Reducing
(10-225# Outlet)



#12 Steam Reducing
(2-15# Outlet)



#35 Reducing
#36 Back Press.

#27 Reducing
#47 Back Press.

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Diaphragm Control Valves

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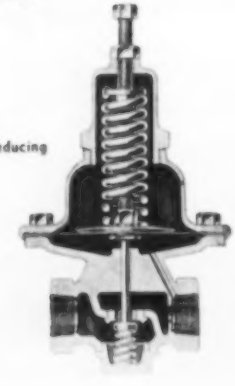

#33 Reducing

MAINTENANCE
ENGINEERING CORPORATION

3011 CLINTON DRIVE
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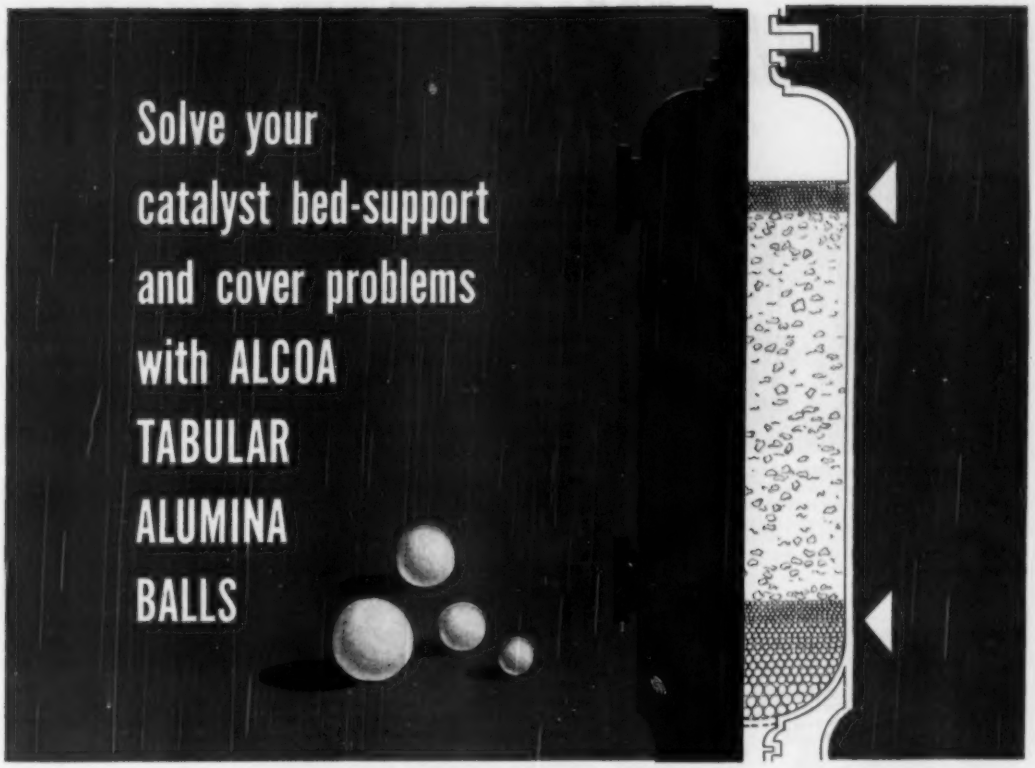
EQUIPMENT WITH ENGINEERING SERVICE

MECO



These hard ceramic balls may make a lot of difference in the operation of your reactor towers. They provide:

Higher Efficiency . . . Better Operation . . .

—The stream is evenly diffused across the catalyst bed . . . Resistance to stream flow is reduced.

—Ceramic balls replace fine mesh inside screens.

—The cover prevents "dancing" of the catalyst when flow is upward . . . Diffuses the stream when flow is downward . . . Holds catalyst in place, should surges occur.

—High purity (99+% Al_2O_3) . . . High resistance to acids and alkalis . . . Chemically and catalytically inert to most products.

Economy . . .

—Simplifies supporting grid.

—High resistance to abrasion, mechanical shock and thermal shock . . . Can withstand sudden temperature changes of more than 1000° C. (1832° F.).

Adaptability . . .

—Any depth of bed-support and cover can be used . . . Five sizes of balls—from ¼" to ¾"—permit a selection best suited to your process.

In addition to their uses as bed-supports and covers, ALCOA Tabular Alumina Balls also offer you money-saving advantages when used as a heat-exchange medium. They have both high heat capacity and high heat conductivity.

Specific heat (at 1000°C.)=0.3 cal./g./°C.
k (at 800°C.)=
0.009 to 0.010 cal./sec./sq. cm./cm./°C.

ALCOA Tabular Alumina Balls may help solve a difficult problem. Let us tell you more about this unique form of alumina. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 6171 Gulf Building, Pittsburgh 19, Pennsylvania.

Alcoa Chemicals

ALCOA

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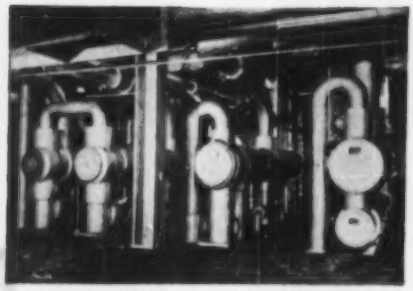
ACTIVATED ALUMINAS • CALCINED ALUMINAS • HYDRATED ALUMINAS • TABULAR ALUMINAS • LOW SODA ALUMINAS ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE • GALLIUM

five examples of

EFFICIENT HEAT TRANSFER EQUIPMENT

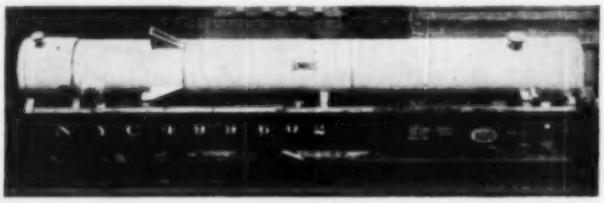


LUMMUS FEED WATER HEATERS and HEAT EXCHANGERS—*Left to right, this installation consists of (a) high pressure feed water heaters: design pressure of 1,100 psi, tested at 2,200 psi on the tube side—effective surface areas, 935 and 1,355 sq. ft. respectively; (b) intermediate-pressure heater, with effective surface area of 1,310 sq. ft.; (c) low-pressure heater effective surface 1,750 sq. ft.*

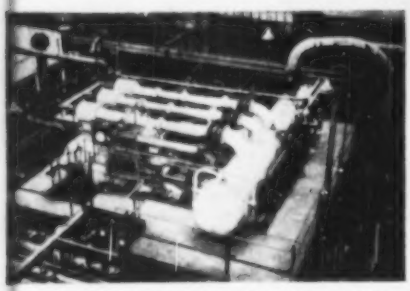
To serve most efficiently in power, refinery, or process plant, heat-transfer equipment must combine enlightened design with superior materials and high-calibre workmanship. Just such a "formula" is realized in each of these five units, representing some of the many types of equipment which Lummus designs and builds to help raise the output and lower the costs of industry.

Lummus, which operates its own manufacturing plant, has an unusually valuable background of experience to apply to your heat exchanger requirements. Throughout the world, Lummus units are operating economically through wide temperature ranges and pressures varying from near-total vacuum to 4,000 psi.

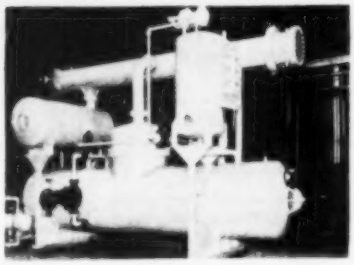
Special-design or standardized, the best formula for efficient heat transfer in your plant is "designed and built by Lummus."



LUMMUS MULTILOK CLOSURES—*This catalyst reactor is one of many types of high-pressure equipment with Lummus patented Multilok Closures. These trouble-saving, cost-saving closures are used on feed water heaters and on refinery, chemical, and general industrial high-pressure units with both stationary and floating heads.*



LUMMUS STEAM JET REFRIGERATION UNIT—*This 350-ton unit, shown before insulation and painting, is installed in the wax de-oiling unit of a large modern refinery. Furnished complete with surface-type condensers and all control equipment, this Lummus unit is arranged so that any single booster or balanced combination of boosters can be operated at reduced tonnage.*



LUMMUS EVAPORATORS—*Lummus kept this package unit within space limitations by mounting the deaerating feed preheater, the evaporator condenser, the condensate receiver, and the control equipments all on common supports with the evaporator. Evaporators of this type are continuously producing vapors with less than 1.0 p.p.m. solids content when the total solids in the shell liquid is maintained at 3,000 p.p.m.*

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Heat Exchanger Division
385 Madison Avenue, New York 17, N. Y.

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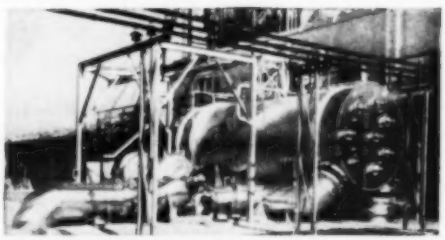

LUMMUS CONDENSERS—*This 27,500-square-foot, 2-pass, nondivided waterbox-type surface condenser is a part of a Lummus installation for a southern utility. It was furnished complete with 2-stage, twin-element air ejector and single-stage priming ejector.*

LOOK TO LUMMUS for Steam Surface Condensers • Evaporators • Feed Water Heaters • Boiler Blowdown Heat Exchangers Steam Jet Air Ejectors • Steam Jet Refrigeration • Barometric Condensers • Heat Exchangers • Process Condensers • Reboilers Steam Generators (Indirect Fired) • Fuel Oil Heaters • Lubricating Oil Coolers • Pipe Line Coolers • Jacket Water Coolers

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Graphic Panel Installation	Application	Graphic Panel Engineering
CONTINENTAL OIL CO. Denver, Colo.	TCC Cracking Unit 4,800 bbl./day	Lummus
COSDEN PETROLEUM CORP Big Spring, Texas	UOP Fluid cat. 6,000 bbl./day	UOP Panellit
DEEP ROCK OIL CO. Cushing, Okla.	UOP Fluid cat. 5,000 bbl./day	UOP Panellit
GLOBE OIL & REF. CO. Lemont, Ill.	UOP Fluid cat. 6,000 bbl./day	UOP Panellit
INDIANA FARM BUREAU Evansville, Ind.	Complete refinery 5,000 bbl./day	UOP Panellit
MAGNOLIA PETROLEUM CO Beaumont, Texas	TCC Cracking Units 45,000 bbl. day total	Lummus
OLD DUTCH REFINING CO. Muskegon, Mich.	UOP Platformer 1,500 bbl./day	UOP Panellit
PAN AM SOUTHERN CORP. El Dorado, Ark.	Delayed coker 9,300 bbl./day	Lummus G.E.
ROCK ISLAND REF. CO. Indianapolis, Ind.	Complete refinery 10,000 bbl./day	UOP Panellit
SHELL OIL CO. OF CANADA Montreal, Quebec	Solutizer 7,000 bbl./day	Shell Peacock
SOC. GEN des HUILES DE PET Dunkirk, France	Dist. 26,000 bbl. day Lube 9,000 bbl. day	Lummus
STANDARD OIL CO. (OHIO) Lima, Ohio	Dist. 9,000 bbl. day Lube 3,500 bbl. day	Lummus G. E.-Sohio
SUN OIL CO. Toledo, Ohio	Houdriflow cat. 30,000 bbl./day	Sun-Houdry Panellit
TIDEWATER ASSOC. OIL CO. Drumright, Okla.	Houdriflow 4,500 bbl./day	Panellit
VENEZUELAN OIL CONCESSIONS LTD. Cardon, Venezuela	Prop. Deasph. Unit 2,500 bbl. day	Lummus Asiatic
WOOD RIVER OIL & REF. CO. Hartford, Ill.	UOP Fluid cat. 7,500 bbl./day	UOP Panellit

This list does not include refineries using NULLMATIC M/P Stations and Remote-Set Controllers on conventional control boards — nor chemical plants using this equipment on graphic and other types of panels.

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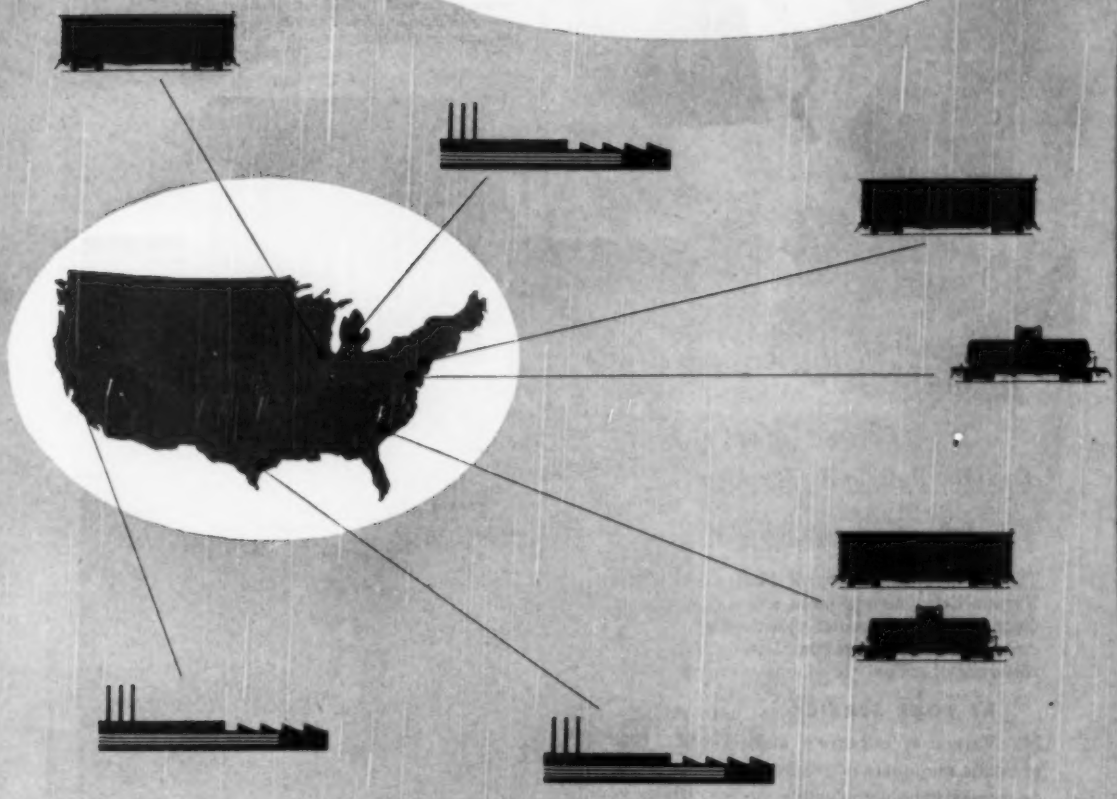

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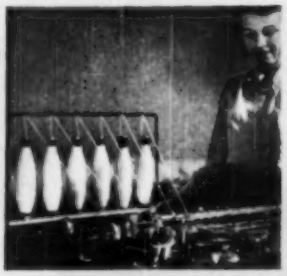
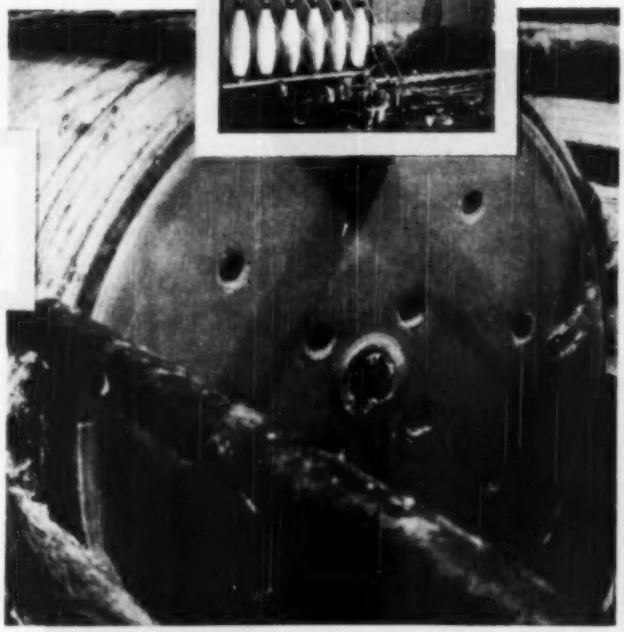
Gives You

Greater Fabric Uniformity





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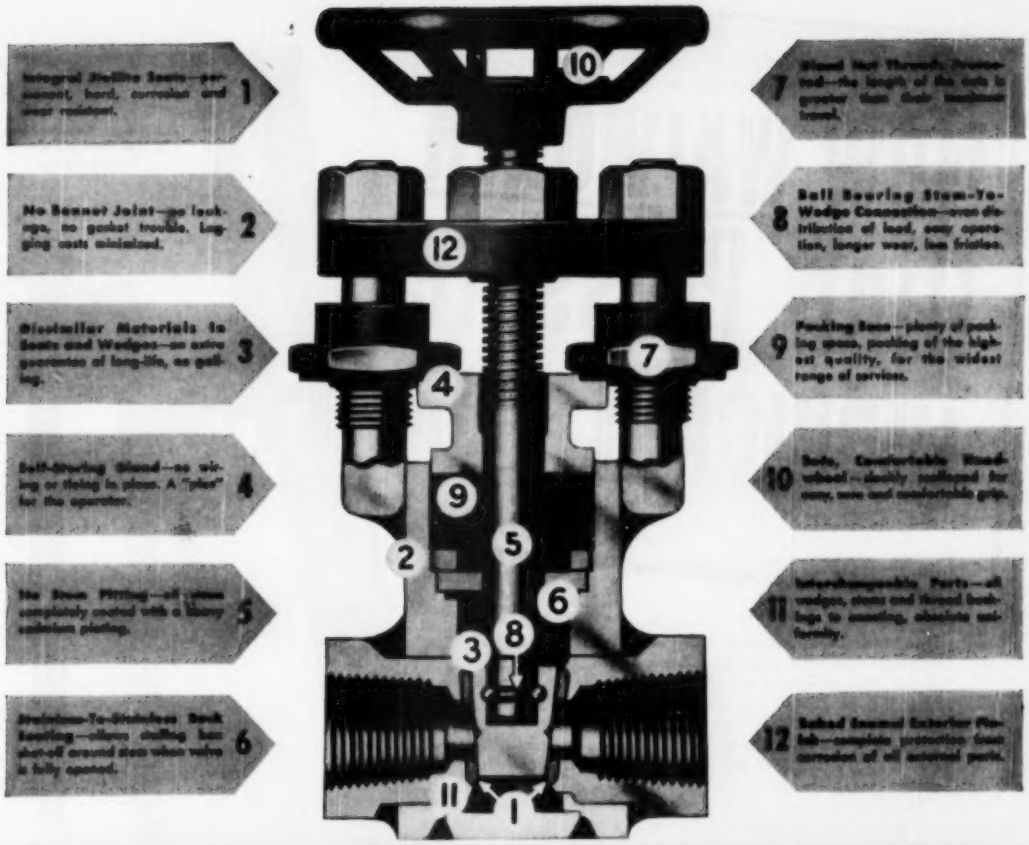
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Baked Enamel Exterior Finish—complete protection from corrosion of all external parts. 12
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They're known, in a large oil company, as "those tough and tight valves" . . . they combine twelve superiorities available in no other valve . . . they're modern in every detail even to the safe, comfortable, sleekly scolloped hand wheel. They're the *general purpose* Hancock Steel Gate WELDVALVES . . . Check them for yourself. You'll find that Hancock Gate WELDVALVES will take the toughest services, stay tight month-after-month . . . Costing no more than ordinary valves, Hancock Gate WELDVALVES give you integral stellite seats that mean years of trouble-free operation; a modern, functional design that eliminates bonnet leakage and gasket troubles, and ten other reasons why their usage is growing every day . . . Hancock Steel Gate WELDVALVES are designed for 800# at 750 deg. F. or 2000# at 100 deg. F. Sizes up to 2 inches.

Write today for the new Bulletin 202 on General Purpose Hancock Steel Gate WELDVALVES.

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New WALWORTH High Pressure LUBRICANT GUN

Save Time—Save Money. With this simple, rugged portable device, it is possible to save in excess of 50% of the time generally required to lubricate Lubricated Plug Valves. It will economically and efficiently handle the stiffest grades of Walworth lubricants.

The gun is self-priming, may be used in any position, and because of its safety features cannot injure the valve.

High pressure button type grease gun fittings—instead of the lubricant screw which is usually furnished—are available for installation on the valve. By painting the valve a distinguishing color to show the service under which the valve operates, and painting the barrel of the gun with the same color, untrained personnel can lubricate valves with the assurance that the correct lubricant has been used.

Walworth has improved and simplified its lubricants so that with a minimum of nine lubricants it is now possible to handle satisfactorily practically all industrial services. The new Walworth 517 and 514 lubricants will take care of 95% of the service conditions encountered in the handling of Petroleum Products and Gas Pipe Lines. The other seven lubricants will take care of most other petroleum, chemical, and industrial services.

All Walworth lubricants are available in Jumbo stick size, individually wrapped and packed 10 sticks per box. Two Jumbo size sticks will completely fill the barrel of the Walworth Lubricant Gun.

for lubricating lubricated plug valves

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For best results use Walworth Lubricants in Walworth Lubricated Plug Valves.

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CHEMICO
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A NEW WAY
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Sulfuric Acid

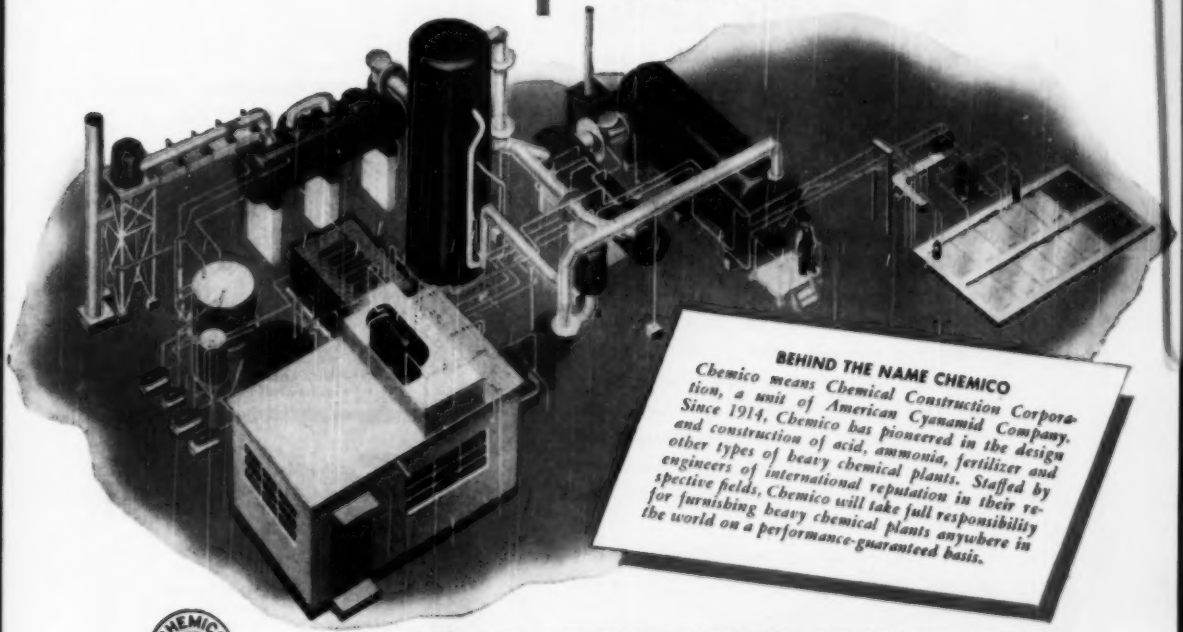
Whether you make or buy sulfuric acid, this simple new-type Chemico plant will be of special interest to you. Here's why . . .

Chemico's new process for manufacturing sulfuric acid from sulfur makes it possible for you to *replace* or *enlarge* your present facilities *at considerably less cost* than for the standard type contact plant.

The simplicity of this new Chemico plant is the basic reason for its low cost. *These seven major items of equipment* — usually found in present-type contact acid plants — *have been eliminated*: drying tower, gas filter, heat exchanger, SO_3 cooler, acid coolers, acid circulating and transfer pumps, and diluting equipment. In addition, the distinctive features listed below assure more efficient production.

DISTINCTIVE FEATURES

- A quench converter eliminates heat exchangers . . . assures higher yield from raw sulfur . . . virtually eliminates atmospheric contamination due to unconverted SO_3.
- A multiple-stage dip-pipe absorption system, operating by gravity flow, eliminates the need to distribute acid over packed absorbing towers.
- Water evaporation from absorber acid solutions removes heat of absorption and the sensible heat of the hot gases. Only the product acid requires cooling before storage.
- A built-in Pease-Anthony Venturi Scrubber insures mist elimination in the exhaust stack.
- Plants of this new type deliver sulfuric acid of any strength up to 95% H_2SO_4.



BEHIND THE NAME CHEMICO

Chemico means Chemical Construction Corporation, a unit of American Cyanamid Company. Since 1914, Chemico has pioneered in the design and construction of acid, ammonia, fertilizer and other types of heavy chemical plants. Staffed by engineers of international reputation in their respective fields, Chemico will take full responsibility for furnishing heavy chemical plants anywhere in the world on a performance-guaranteed basis.

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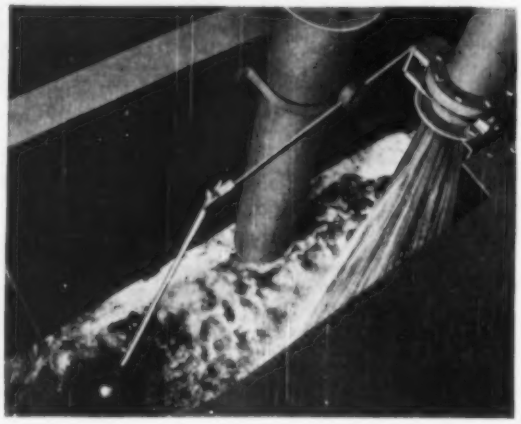
R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



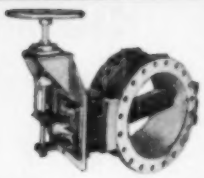
R-S FLOAT VALVE for Sewage Service

The R-S Heavy Duty Direct Action Float Valve controls the water level in a wet well of a sewage treatment plant at Quakertown, Pennsylvania. Illustration shows valve approximately 25% open. At the high level, practically drip tight shut off is obtained with metal-to-metal seat. The adjustable float connection keeps the float away from the area of turbulence.

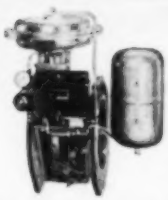
R-S Valves are used in air, gas, liquid, steam and semi-solid service for the shut off and regulation of volume and pressure, pressure relief, liquid level control, back pressure, water hammer, steam hammer, constant differential pressure, output control of pumps, fans, engines, turbines and automatic combustion. Suitable for service in the temperature range from minus 300°F to plus 2000°F. 2 to 2500 psig.

Specify R-S Valves for simplified control and shut off. Consult with your local R-S Valve Engineers or write direct.

R-S PRODUCTS CORPORATION
Wayne Junction • Philadelphia 44, Pa.



No. 700—20-inch 50-pound Cast Iron Valve with rubber seat, Type B-8934, for positive 100% shut-off. Heavy duty handwheel control with threaded reach rod. Type B-9469.



No. 781—Fourteen-inch Heavy Duty Cast Iron Valve with 125-pound American Standard flanges and drilling. Mounting bracket, crank arm, reach rod and linkage together with springless diaphragm top including positioner, gauge and an auxiliary tank as an integral part of the unit. Should all air fail, pressure in the tank will stroke the valve. Note the bronze bushings in bracket through which the air motor shaft passes.

No. 780—Eight-inch Off Center Valve for control of 15 psig saturated steam with 1 psi drop. Series 15, 150 - pound American Standard raised face flanges. Double crank arm with adjustable weights for accurate setting. Cylinder is not an actuator but simply a dash pot. Note 2-inch flanged outlet for overload relief.

No. 782—Heavy Duty Wafer Type Valve, rubber seated, 5° angle seated vane with enclosed gear reduction drive.

Note that there is plenty of room to easily remove the gland and repack the stuffing box.

ALKYLATION
Kellogg has engineered Alkylation units for the following leading petroleum refining companies:
• Anglo-Iranian Oil Co., Ltd.
• Argentine Government Oil Fields
• Cities Service Oil Co. (Del.)
• Cities Service Refining Corp.
• Continental Oil Co.
• California Refining Co.
• Imperial Oil Limited
• Magnolia Petroleum Co.
• Mid-Continent Petroleum Corp.
• Pan American Refining Corp.
• Standard Oil Co. (Ohio)
• Standard Oil Co. (Indiana)
• Union Oil Company of California
• Utah Oil Refining Co.
Including butane isomerization

More than 1½ million gallons of 90+ alkylate flow every 24 hours from Kellogg-engineered Alkylation units!

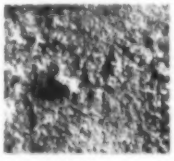
Yes! Kellogg-built Alkylation units produce 1 gallon of high-octane alkylate to every 65 gallons of gasoline produced in America!

BORN to meet the needs for wartime aviation fuels, Alkylation units are today contributing significantly to refinery operations. Not only are they being utilized for the production of aviation gasoline, but, more importantly, they are supplying high-octane blending components for premium motor fuel.

Kellogg has always recommended sulphuric acid Alkylation because of lower initial and maintenance costs and safer operation. The soundness of this recommendation is indicated by the number of companies that have continued the profitable operation under peacetime conditions of Kellogg's wartime sulphuric acid units.

Three new units (two in the U. S. and one abroad) now being built by Kellogg indicate that the Alkylation process is again being carefully evaluated by refiners as a means of meeting the ever-increasing octane levels.

ACID HANDLING AND HEAT REMOVAL ARE KEY PROBLEMS IN DESIGN



Alkylation employs corrosive acids in the catalyst reaction and is highly exothermic. To meet the requirements of the latter, Kellogg designed a special system of auto-refrigeration which reduces both initial and maintenance costs. To combat corrosion, Kellogg's metallurgical groups, who have conducted a continuous study of the problem for many years, incorporate in current designs all of the latest improvements in corrosive handling equipment and piping design.

IT TAKES ALL SEVEN TO PRODUCE GREATER EARNING POWER . . .

1 THE DEVELOPMENT "TOOLS"
—laboratories, pilot plants and recognized specialists to prove and improve processing and equipment ideas.

2 PROCESS ENGINEERING
by three distinct groups of specialists—*sequence* engineers, *unit* engineers and *development* engineers—supported by an extensive reservoir of exclusive data.

3. Specialists in every phase of DESIGN ENGINEERING

Beyond eight specialized design divisions, there are several groups of specialists that serve the engineering departments as a whole. Contributing greatly to lowered cost of Kellogg-designed units is the STANDARDS SECTION. These men devote their full time to establishing general technical standards that are followed by all engineering sections. In addition, they produce charts of prescribed engineering details, special templates and even, on occasion, special slide rules. Not only does this section's work save vast numbers of engineering hours but it helps assure a continuity of high quality in all Kellogg engineering.

4 SPECIALIZED BUYERS
backed by the cumulative buying power of the largest company in the business.

5 COMPLETE FABRICATING FACILITIES
to make schedule deadlines and to develop workable "firsts" in refinery equipment.

6 CONSTRUCTION KNOW-HOW
acquired in completing hundreds of major jobs, plus an ample supply of the proper tools, and the constant development of new money-and-time-saving methods on the construction lot.

7 PRACTICAL OPERATING COUNSEL
on all design and construction, achieved through practical operating men working as an integral part of the company.

. . . AND ONLY KELLOGG HAS ALL SEVEN!

The M. W. Kellogg Company, (a subsidiary of Pullman Incorporated), New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris

For a bigger choice of better piping
Choose from the broad CRANE line

LOW IN PRICE . . . HIGH IN PERFORMANCE

Need small steel valves you can count on for quality performance . . . yet are low in initial and maintenance costs? Then specify these Crane 600-Pound Union Bonnet Small Steel Gates.

They're strong—body, bonnet, and yoke are high quality Crane carbon steel. And they're easy to operate. Wedge disc, closely guided throughout travel, does not get out of line or jam in body. Non-rigid disc-stem connection prevents stem distortion and binding of parts.

Want maximum protection against leakage? Then note these features: Stuffing box—deep and filled with high-quality packing. Bonnet joint—male and female design, fitted with soft iron gasket. Body seat rings—securely rolled-in to prevent loosening in service. See your No. 49 Crane Catalog, or send for Circular AD-1741.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
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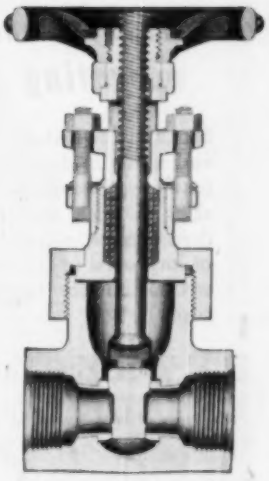
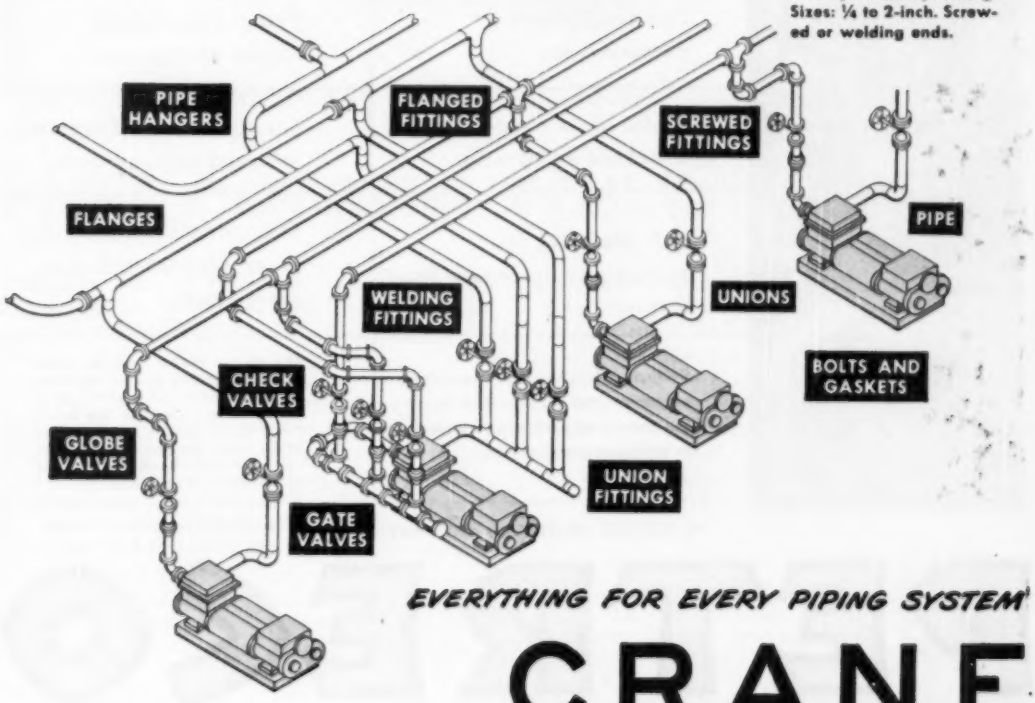


No. 3602X, 600-Pound Small Steel Gate for oil or oil vapor up to 1000° F. Exelloy to Exelloy seating. Sizes: ¼ to 2-inch. Screwed or welding ends.

DISTILLATION PUMP ROOM PIPING, FOR EXAMPLE, CAN BE COMPLETELY EQUIPPED ON ONE ORDER TO CRANE



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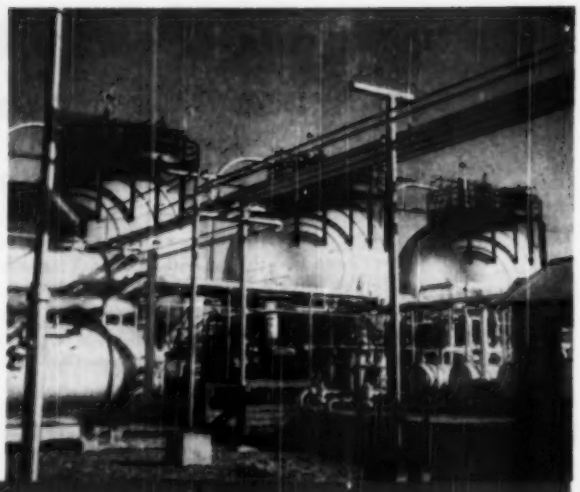
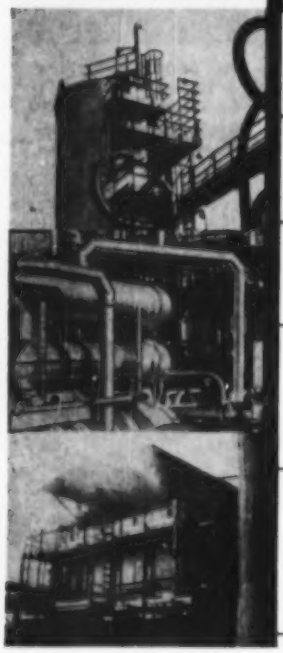
PETRECO DESALTING

assures maximum operating economy

Mechanical failures caused by salts and solids in the charging crudes are costly, *yet avoidable.* In one refinery after another, Petreco Desalting has demonstrated a rapid pay-out in terms of improved operations, increased on-stream time and lowered maintenance costs.



PETRECO DESALTING



assures these operating advantages	makes possible these profitable economies
Higher sustained cracking temperatures	*Deeper cracking, increased gasoline yield*
Less plugging in furnace tubes	*Fewer tube failures, higher charge rates*
Reduced corrosion in overhead equipment	*Savings in shut-down time, material replacements*
Less plugging in exchangers, improved flow	*Decreased clean-out costs, more efficient exchange, longer runs*

Petreco offers the most complete, extensive and experienced desalting service organization available in the petroleum industry.

The above listed benefits from Petreco Desalting are not the only benefits cited by users of the process. They are, however, the benefits cited universally as substantial profit items. For complete information on Petreco Desalting, write to or call any Petreco office.

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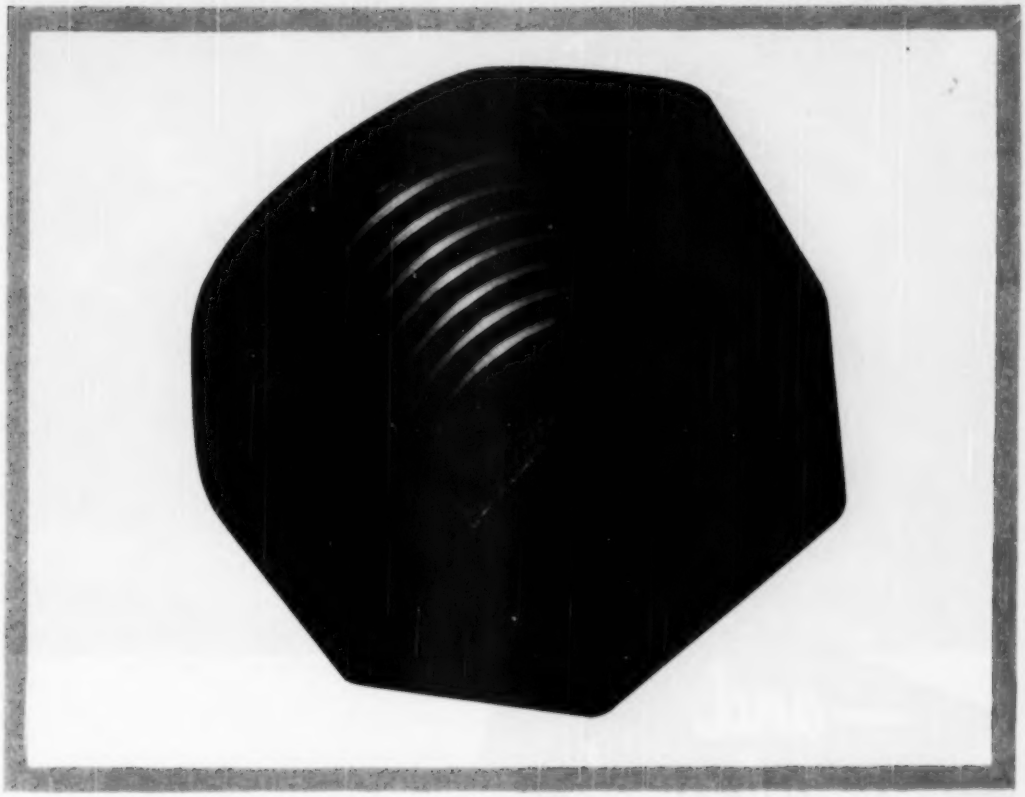
PETRECO

SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PR 50-5



Hot Forged for Strength

There's no cause for concern about premature nut failure when you use the Bethlehem Quenched Nut in high-temperature, high-pressure bolting applications. For this nut can take it.

The Bethlehem Quenched Nut has the ability to stay on the job for long periods of time because of its built-in strength. This is the result of hot forging. Instead of being punched from a hot bar, as is the case with ordinary nuts, the Quenched Nut is made by forging and extruding hot metal into a forming die, after which it is quenched and tempered. This results in a nut sufficiently strong to break virtually any stud or bolt on which it is used.

Besides, the Quenched Nut has a tough grain structure, and its oxidized sides are resistant to corrosion. In addition, it has a ground bearing surface which is vastly superior to common, machined surfaces.

The Quenched Nut is a product of Bethlehem's fastener plant at Lebanon, Pa. It conforms to Grade 2H of ASTM Specification A194, and is carried in stock in bolt sizes from ⅜ in. to 3½ in. Lebanon Plant also stocks nuts in Grades 0, 2, and 4. If you'd like additional information about the Quenched Nut, or any of the other Bethlehem fastener items for high-temperature bolting, put it up to a Bethlehem man, or write to us at Bethlehem, Pa.

BETHLEHEM STEEL COMPANY
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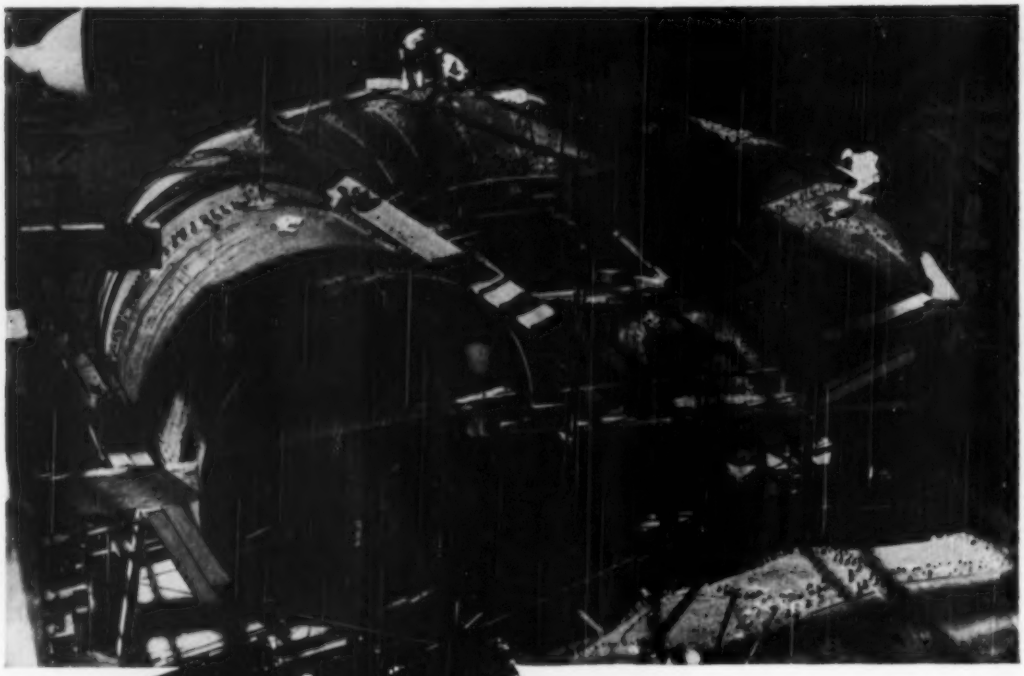
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Bethlehem supplies every type of Fastener



—and special work too!

Turning out high-performance refinery and chemical plant equipment, record-making tankers and cargo ships is our main business. Such work calls for facilities so vast and skills so varied that Sun Ship also does a wide assortment of special industrial jobs—here, for example, building the scroll case of a turbine for generating electricity by water power . . . Sun Ship facilities and skills are at *your* command.

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SHIPBUILDING & DRY DOCK COMPANY

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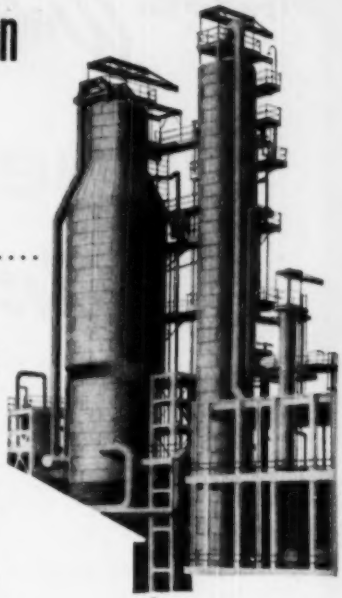
Looking Toward Universal Operation ...While Handling Sour Crudes



PROBLEM: *Economical flashing of a lube cut at 750°F to a furfural refining stock in which sour asphalt base crudes from any source must be handled.*

DESIGN: *Flash tower for semi-automatic operation built of Lukens Stainless-Clad Steel. Design assures resistance to thermal shock. Protection from high-temperature corrosion by sulfur compounds and hydrochloric acid through inner stainless surface. Strength and rigidity through its steel backing.*

END RESULT: *Long on-stream service with continual through-puts of 20,000 bbls/day. Low maintenance. Long equipment life. Reduced manpower. Closer approach to universal operation.*

These benefits are typical of results achieved with newly developed, more efficient processing equipment. And wherever design, fabrication and materials selection must be critically coordinated, you will find the economical answer in applied *Lukenomics*. Lukenomics combines the experience of designers, engineers and equipment builders with Lukens' knowledge of materials and their application gained over 140 years as the world's leading producer of specialty steel plates, heads and steel plate shapes.

It's sound investment insurance to put Lukenomics to work on your equipment problems. There are progressive fabricators who can do this for you. Get in touch with them or write our Manager of Marketing Service, stating your problem. There's a Lukenomics team ready to go to work on it. Lukens Steel Company, 404 Lukens Building, Coatesville, Pa.

This flash tower was engineered by E. B. Badger & Sons Co. and fabricated by Sun Shipbuilding & Dry Dock Co. for Socony-Vacuum Oil Company. Made of Lukens Stainless-Clad Steel, Type 405, its design incorporates a Lukens span head measuring 20' 4" diameter, largest ever spun.

LUKENS STEEL COMPANY

BETTER PRODUCTS FOR BETTER EQUIPMENT

PAGE *Welding* ELECTRODES

Page-Allegheny *Stainless Steel*

AC or DC

ARC
—stable even at very low amperage

SLAG
—clean, easily removed

COATING
—resists cracking down to very short stubs

SELECTION
—complete line for welding every type of stainless

DELIVERY
—prompt from warehouses in Chicago, Denver, Houston, Philadelphia, San Francisco and the factory at Monessen, Pa.

ACCO

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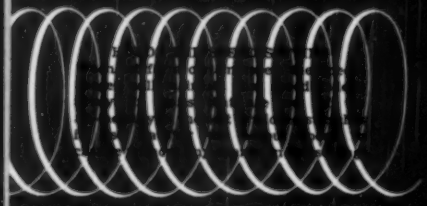


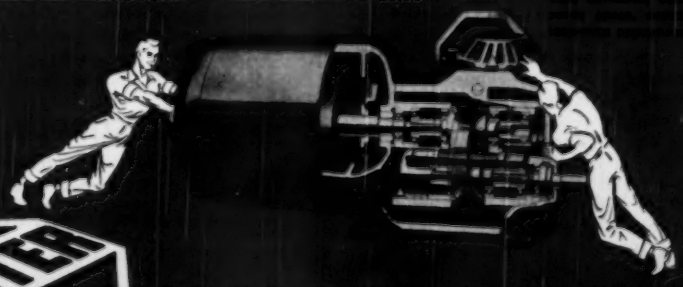
On thousands of applications in every field of manufacture, stepless variable speed operation assures exactly the right speed for every operation . . . for every operator . . . the right speeds for each change in the consistency or shape of the material being processed. Such variable speed operation pays off in higher rates of production, a more uniform better quality product and more efficient performance of your equipment and your operators.

Master Speedrangers provide all these advantages inherent to variable speed operation. And in addition their ALL-METAL construction gives you the five additional advantages illustrated on this page . . . advantages that can be obtained only with an all-metal unit.

ALL METAL CONSTRUCTION

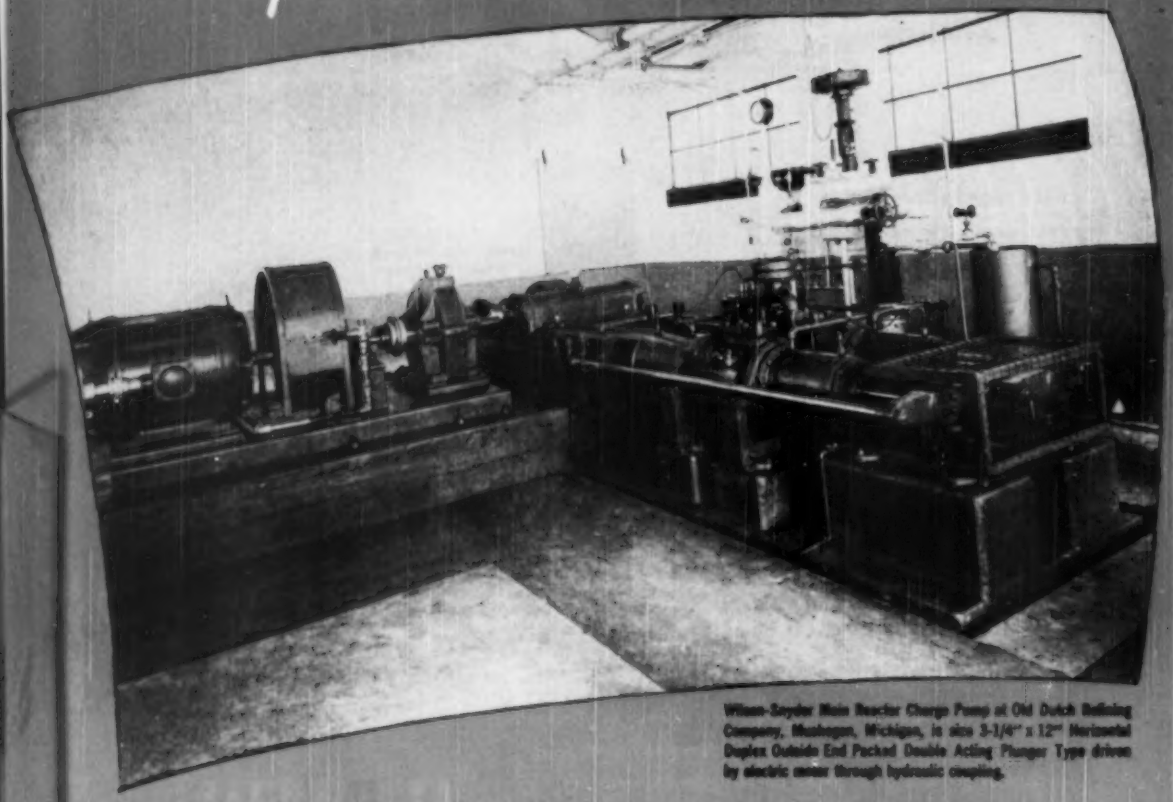
The next time you need a drive for material processing, handling, and conveying equipment; mixers and agitators; welding-positioners; machine tool drives; testing and calibrating equipment . . . to name only a few . . . see what a really remarkable job Master Speedrangers can do for you. Write for Data 7525, new booklet on Speedrangers.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO



MASTER SPEEDRANGERS

We are proud to be on the team!



Wilson-Snyder Main Reactor Charge Pump at Old Dutch Refining Company, Muskegon, Michigan, is size 3-1/4" x 12" Horizontal Duplex Outside End Packed Double Acting Plunger Type driven by electric motor through hydraulic coupling.

Wilson-Snyder Pump selected for the "heart" of UOP Platforming Process

PLATFORMING . . . the petroleum refining process that utilizes a catalyst containing platinum . . . was discovered and developed by Universal Oil Products Company. The process is employed to improve the octane characteristics of straight run and natural gasolines, and has already proved its merit in commercial operation at the Muskegon, Michigan refinery of Old Dutch Refining Company.

Wilson-Snyder Refinery Pumps have long enjoyed an excellent reputation for performance and reliability. That is the reason UOP selected a Wilson-Snyder as the Main Reactor Charge Pump for this first platforming installation.

You, too, can DEPEND on Wilson-Snyder Refinery Pumps . . . especially in critical process operations where performance and reliability count the most.

A complete line of Wilson-Snyder reciprocating and centrifugal pumps are available for all types of refinery operations. Write for engineering information.

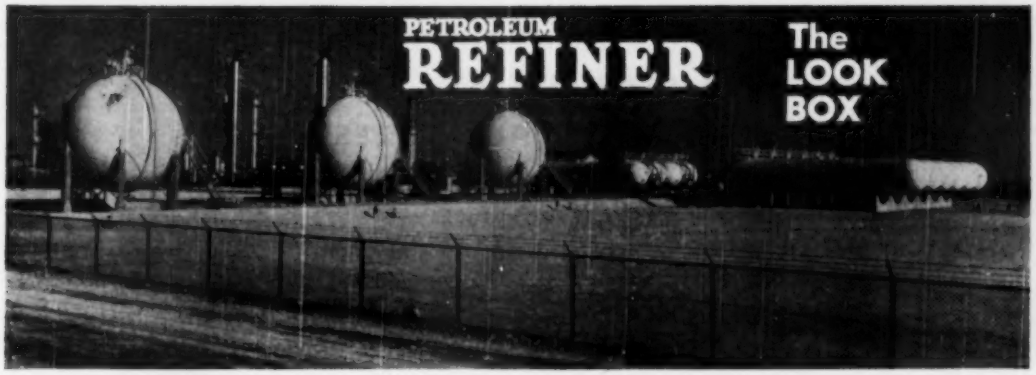
OIL WELL SUPPLY COMPANY

Wilson-Snyder Manufacturing Division
Braddock, Pa.

And all Oil Well Supply Company Offices

USS "OILWELL"

UNITED STATES STEEL



The Annual Process Issue

THIS is the 1950 Process Issue of PETROLEUM REFINER. In this issue a special section is devoted to the review of several processes that have been introduced within the past year or so, or that have been notably improved in that period.

It is interesting to note that much activity is reported for the catalytic cracking processes. These processes are of high current interest. Catalytic cracking capacity has been so increased in our refineries that it may be counted next to crude oil distillation as a major process of the industry. Introduced long before World War II, catalytic cracking operations have so much to offer refiners that a number of development groups have engaged in intensive efforts to devise new processes and improve existing ones. Several distinct processes have evolved. Catalytic cracking, heavily installed as a war measure, has proven its utility for peacetime competitive manufacture of high quality motor gasolines. The trend has been both to the development of more efficient large-thruput process units, and also to the design of units economically feasible for the smaller refineries. There has been strong interest in recent years in processes for octane number improvement of gasolines and naphthas.

A new catalytic reforming process, Platforming, has excited comment. A commercial unit has been in operation for some time, and further construction is scheduled.

The Furfural process for solvent refining has been quite successfully adapted to the production of diesel oils, furnace oils, and the like, in the new refinery of The Texas Company located at Westville, N. J.

A process for making acetylene from petroleum hydrocarbons by electric discharge has been publicized during the last year, and is reported here. Other processes important in petrochemical operations are noted.

The process section begins on page 161.

Better Prepared Than Ever

THE American oil industry is better prepared than ever before to meet any national emergency.

That is the statement of Frank M. Porter president of the American Petroleum Institute, who pointed out early in August that the nation's capacity to produce and refine petroleum, as well as its proved reserves of underground oil, have increased by approximately one-fourth since the climax of World War II created peak demands for petroleum products.

The world knows the role that the American oil industry played in World War II—knows that when oil was called ammunition that the thinking and the effort of oil industry leaders resulted in a magnificent record. So when the API head, whose industry experience, of course, includes those 1941-45 days, says "better prepared," he really rates high oil's ability to deliver in the present military development.

And Mr. Porter is correct, because progressive American oil companies, spurred by the driving force of competition, have plowed back into their business during postwar years more than $8 billion for exploration and development and new facilities. It should be better prepared.

Porter's open letter to oil men in all part of the U. S. follows:

On every hand, American oil men have been questioned as to the industry's ability to meet the nation's needs. Each of you, of course, knows the possibilities of your own operations, but it may be helpful to appraise the position of the industry as a whole.

The American oil industry is better prepared today than ever before to meet any national emergency. Our domestic capacity to produce and refine petroleum has increased around 25 per cent since the peak demands of World War II—during which the Armed Forces of this nation and its Allies never lacked for oil, and all essential civilian needs were met.

In the months immediately ahead, with minor dislocations to be expected, we should be able to furnish all of the military demands for oil products

Top-of-page Photo—Product Storage Area at South Fullerton, Texas. Gasoline Plant with Portion of Plant Visible in Background. Located in Andrews County, Texas, Stanolind Oil and Gas Company operates the plant for a group of 14 owners.

FOR GREATER STABILITY AT HIGH OPERATING TEMPERATURES

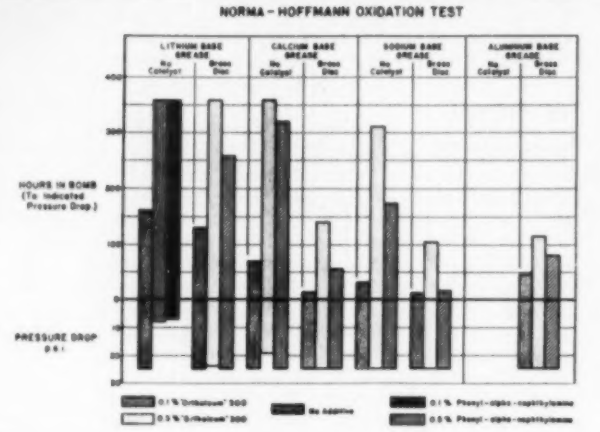
USE DUPONT "ORTHOLEUM" 300 GREASE STABILIZER

The high temperature and high pressure demands put upon greases by modern equipment brings a definite need for greater thermal stability and resistance to oxidation—a quality demand that is passed on to the refiner.

"Ortholeum" 300 Grease Stabilizer has been developed to meet this need. This new additive combines both antioxidant and metal deactivating properties, and the combination imparts oxidation stability to the grease, superior to that attainable with antioxidants alone. In addition, it does not cause discoloration of the finished product.

"Ortholeum" 300 has been evaluated in many types of greases and the Norma-Hoffmann Oxidation Test shows markedly greater effectiveness over compounds such as Phenyl-alpha-naphthylamine. While effective in a non-catalyzed system, its advantages are most marked in a catalyzed system. Test results on several types of greases are shown opposite.

Samples can be obtained for evaluation in your own greases from the nearest Du Pont District Office or from your Du Pont Petroleum Chemicals Representative. For more complete information, ask for Technical Bulletin GS-50.



PHYSICAL PROPERTIES

Appearance	Brown flakes
Melting Range, °F.	
Starts to melt	125
Completely melted	160
Normal Use Concentrations	
Wt. %	0.2 to 1.0
Miscibility with oils and greases	In all proportions above 160°F. Normal use concentrations soluble at all temperatures.

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Better Things for Better Living . . . through Chemistry

Petroleum Chemicals

Make Du Pont the Source for All of Your Gasoline Additives . . . Tetraethyl Lead Compounds (Motor Mix—Aviation Mix)—Antioxidants—Metal Deactivator—Dyes

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and supply the civilian needs for gasoline and heating oils.

Based on the assumption that the military need for oil will increase only as greater amounts of equipment and manpower are engaged in using it, there should be no demand in the immediate future that the industry cannot readily supply.

As to the long range view, no one can predict with complete accuracy what the military needs for oil products may be. The extent to which we will be called upon to supply gasoline, jet and other aviation fuels, fuel oil, Navy special fuels, and other military requirements for petroleum, obviously depends on the turn of international events.

Although we cannot know all that is ahead, the record of our industry is reassuring. In the five years since the end of World War II, American oil companies have been rebuilding, improving and expanding their facilities and creating a substantial reserve productive capacity.

Compared with the peak war year of 1945, total U. S. crude oil production capacity has been increased 27 percent, refining capacity has been increased 21 percent, and proved crude oil reserves have been increased 24 percent.

In these five years American oil companies plowed back into their business more than $8 billion for exploration and development and to provide these new facilities—the great bulk of this from operating profits.

This record and the traditional skill and ingenuity of the American oil industry, give assurance that supplies and facilities will be expanded and adapted with maximum speed and efficiency to meet whatever needs may develop, provided that necessary steel and other essential materials are made available.

America's thousands of oil companies owe their continued progress to the fact that they are privately managed and have competed vigorously for the privilege of serving America better.

The key to the strength of the American oil industry is the driving force of competition. This strength must be preserved if the United States is to remain a power for peace. Even with national planning and restrictions, the nation must continue to rely on private management, and although close and full cooperation with governmental agencies is necessary in times of emergency, nothing should be done that will impair the incentive for competition in normal times.

While wartime restrictions and allocations may again be needed, the amount and severity will be influenced by the record of the industry itself. All of you will agree, I am sure, that the industry will be able to supply the largest possible volume of our national petroleum requirements if we have the largest possible freedom in our operations.

I know that every oil man shares my confidence that this industry can and will continue its record of meeting every challenge on its own initiative.

The qualities of self-restraint, of integrity, of conscience and courage still live in our people. It is not too late to summon these qualities into action.

—HERBERT HOOVER.

Doctors and Oil Men

MARJORIE SHEARON, who writes a weekly "Challenge to Socialism" from Washington, D. C., recently devoted most of an issue to the maneuverings of administration forces in appointing William Hastie to a federal judgeship. Hastie, a Negro, has been called a "communist collaborator" and his record, says Dr. Shearon, certainly indicates nothing less.

"The Hastie confirmation is important not only in itself," Dr. Shearon writes, "but because it would be one more stepping stone toward the Supreme Court of the United States for this man. Truman, we hear, wishes to have the political advantage that would be his if he named a Negro to the Supreme Court. Hastie, we understand, is the man picked for the elevation. The Republicans, shortsightedly, have lacked the guts to oppose him.

"As one man close to the situation in the Senate put it: 'If Hastie were a white man with a background like that, the committee would not confirm him. But since he's a Negro, he'll probably get it.' "

Dr. Shearon then goes on thiswise:

"Some of our readers may find this dull reading. If they are physicians they may say: 'I am too busy to read about Communism. I have time only for medicine.' To such the Editor replies: 'If Stalin and his followers take over the United States because of enemies within as well as without our country, American medicine as we know it will be one of the first things destroyed.' "

The REFINER concurs in the belief that dangers lurk ahead. "There's no doubt about the seriousness of the situation as regards either medicine or oil. So if, in the past you've thought yourself too busy to be concerned with such matters, our urgent suggestion is that you give it another thorough mental going over.

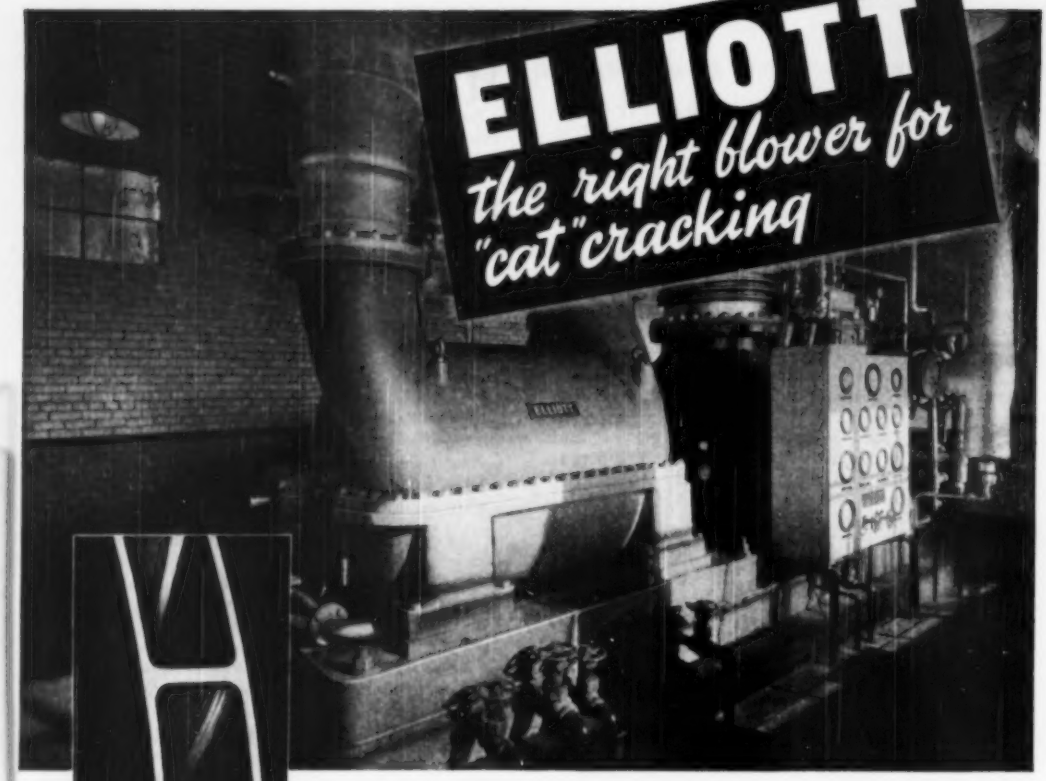
This Matter of More Security

ONE hundred and fifty dollars looks considerably bigger than $85, but a few years hence will the administration's promise of more security really be fulfilled?

Under the law signed late last month some 10 million more people were brought under the social security wing and benefits increased for those already affected. A family now entitled to the $85 maximum will under the new act draw down $150. Which looks like a right healthy increase. But with the government bent on maintaining an inflationary trend, how much more will future one hundred and fifties buy than current eighty-fives?

ELLIOTT

the right blower for "cat" cracking



WELDED IMPELLERS are one of the many reasons why Elliott blowers are getting ever-increasing acceptance for process work. Note the smooth contours, heavy blades, and generally rugged construction (as compared to conventional riveted impellers). Impellers are completely homogenous units, can be made of any weldable material having reasonable mechanical strength.

THIS ELLIOTT TURBINE-DRIVEN AIR BLOWER serves the new fluid "cat" cracker which recently went into service at the Big Spring, Texas, refinery of Cosden Petroleum Corporation. It provides the air for conveying and reactivating the catalyst. Installed at an elevation of 2600 feet above sea level (13.3 psia barometer), this blower is rated at 15,500 inlet cfm and discharges at a pressure of 25 psig. It is direct-connected to an Elliott 1575-hp condensing steam turbine operating at 5900 rpm.

Continuity of operation is an essential of "cat" crackers and other process requirements—an emergency shutdown may result in serious damage to equipment and prolonged loss of production. Elliott units have been designed with this requirement in mind and operating records prove conclusively that they have the rugged dependability necessary to meet the most exacting requirements. Contact your nearest Elliott representative for details.

P-1090

ELLIOTT COMPANY

***Electric Power Dept.*, RIDGWAY, PA.**
***Steam Turbine Dept.*, JEANNETTE, PA.**

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Advances in Petroleum Refining

W. M. HOLADAY

Director, Socony-Vacuum Laboratories,
Socony-Vacuum Oil Co., Inc., New York

AT PRESENT THE OIL industry in the United States has available a variety of processes to maintain a reasonable balance in fuel production to meet expected variations in volume demand during the next decade. An exception may arise in the case of converting additional residual fuel to more valuable products—particularly in view of increased distribution and utilization of natural gas for industrial heating and power applications.

Trends in fuels utilization likely will require development of new refining procedures to raise the anti-knock quality of gasolines. Possible means to accomplish this together with alternative steps which might be taken by auto manufacturers to utilize more efficiently the anti-knock quality of gasoline now being made were presented by Mr. Holaday before the Fourth World Power Conference held recently in London.

THE consumption of fuel energy in the form of coal, petroleum, and natural gas in the United States has practically doubled in the past 30 years. At the beginning of this period, petroleum and gas supplied only 20 percent of the energy requirement. In contrast, these energy sources now provide over 50 percent of the 290 billion therms (1 therm = 100,000 B.Th.U. = 25,200 kcal.) per year which constitute the current consumption of fuel energy. In other words, U. S. consumption of petroleum products to provide heat, power, and transportation has grown by leaps and bounds in the past three decades.

The major factor affecting this increase has been the rapid development of the automotive engine with its attendant demand for large volumes of gasoline. Shortly after World War I, this demand began to exceed the natural availability of gasoline in crude oils. Therefore, in order to obtain a proper balance among the products derived from crude, refining techniques had to be developed to convert fuel oil fractions to motor gasoline. Although this condition existed in the U. S., gasoline had not yet become the primary product in most other countries of the world and, consequently, the conversion processes practiced in the U. S. have not been used as extensively in other countries. There are indications, however, that this situation may change within the next 10-15 years.

Inasmuch as motor gasoline has had the greatest effect on the research, development, and application of new refining techniques in the U. S., the purpose of this paper is to review the major advances in petroleum refining which have been made to balance the supply and demand for fuels and to improve product quality. Supplementing this review, the utilization aspects of fuels in general and motor gasoline in particular are also discussed and considered with reference to future trends in the science of petroleum processing.

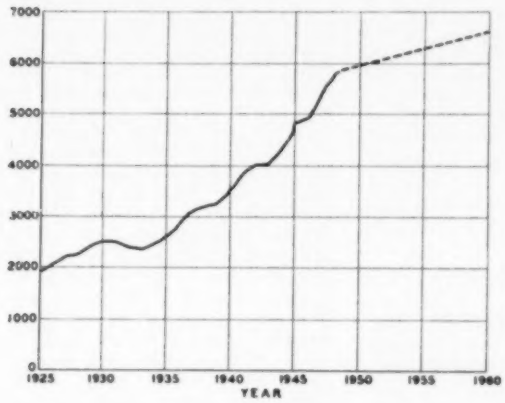
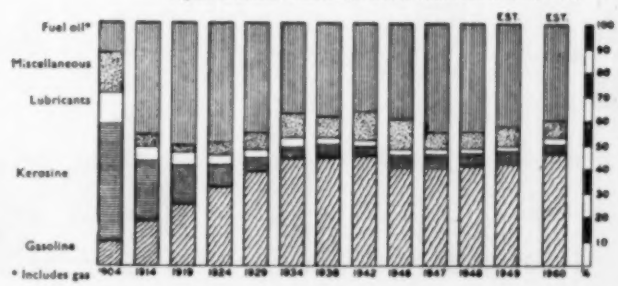


Figure 1. (Left) Consumption of Petroleum Products in the U. S. (in thousands of barrels per day).

Simple fractional distillation of an average crude petroleum will generally yield approximately 20-30 percent gasoline, 30-45 percent distillate fuels including kerosine, and 25-50 percent residual fuel oil. Certain crudes fall far outside these averages, some consisting almost entirely of gasoline, others almost entirely of residual fuel. As the petroleum industry developed, the demand for individual products could not be matched with the yields obtained by simple distillation of the available crude oils. Even great disparity in prices could not effect this balance. When the industry was small and kerosine was the primary product, gasoline was disposed of in rivers and streams, and heavy residual were poured on the ground. Such unhealthy economic practices were not long acceptable, and new refining techniques were adopted to bring the supply of the various products more nearly in line with demand. Today the flexibility in product balance is such that the refiner may, by installation of proper equipment, limit gasoline production from total crude to as low as 20-25 percent or increase it to as high as 60-70 percent. The latter is possible, however,

Figure 2. (Below) Petroleum Product Distribution in the U. S.



only with high investment and operating costs.

Figure 1 charts the consumption of petroleum products in the U. S. during the past 25 years and the estimated probable demand over the next 10 years. Figure 2 resolves this total demand in terms of principal petroleum products. Similar, but less extensive and not as well authenticated data involving other parts of the world are shown in Figures 3 and 4. A review of these data will indicate that products consumption outside the U. S. most closely matches that which occurred in this country shortly after World War I. Such demand falls fairly well within the limits of what can be made available by simple distillation of many crude oils.

The change in emphasis from fuel oil and kerosine production to gasoline occurred in the U. S. during World War I. Since that time, gasoline consumption has increased from 20 percent to over 40 percent, with a corresponding decrease in kerosine and fuel oil. While the total consumption of petroleum products is expected to increase markedly in the U. S. as shown in Figure 1, the relative percentage of fuels as shown in Figure 2 is not expected to change significantly during the next decade.

Figure 5 charts the past and projected consumption of the various types of fuel oil in the U. S. A decrease in the yield of residual fuel in favor of distillates is apparent. The effect of a reversal in this trend during the period covered by World War II, brought about by wartime demands for industrial and marine equipment, has been eliminated during the postwar years.

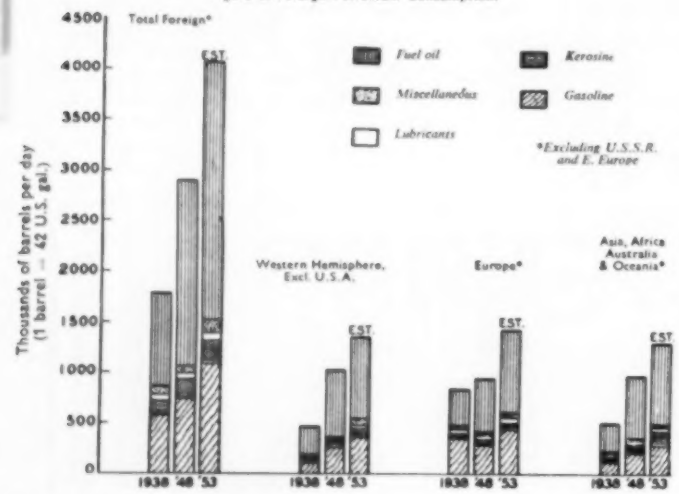
The demand for gasoline in the U. S. has been the motivating force in promoting almost all of the refining advances. Downward trends in fuel-oil yield have, of course, been a direct result, since these products are the source of incremental motor fuels.

Increased Gasoline Yield and Quality

Thermal cracking and reforming. It was accidentally discovered in 1861 that heavy crude petroleum fractions held at a high temperature for a period of time would decompose to form lighter materials, principally gasoline and gas. Since for the next half-century substantially no demand for gasoline existed, this principle was not developed or commercially exploited in this time. As Figure 1 indicates, demands for gasoline began to exceed natural availability in crude petroleum immediately following World War I, and thermal cracking to convert distillate fuel oil fractions to gasoline began to be practiced commercially. Marked advances have been made since that time in developing optimum conditions of time, temperature, and pressure and in designing equipment to give long on-stream times and high yields of desirable products.

Thermal cracking, fortuitously, yielded gasolines of higher anti-knock quality —octane number—than motor fuel distilled directly from crude petroleum. As octane number became a more important factor, thermal processing of low octane number straight-run heavy naphthas was undertaken. This treatment, called reforming, not only improves the anti-knock quality markedly, but also improves the over-all volatility of the fuel. Losses, however, may be substantial, usually varying between 15 percent and 30 percent, depending upon the intensity of cracking.

Figure 3. Foreign Petroleum Consumption.



As indicated in Figure 6, thermal cracking and re-forming contributed markedly to over-all gasoline production from its inception through 1938. At this time, nearly 50 percent of the gasoline consumed in the U. S. consisted of cracked material. Since then, the installation of thermal cracking has declined in favor of catalytic cracking. Thermal processing is now restricted largely to re-forming and to the cracking of residual stocks rather than distillates.

Coking, one variation of thermal cracking, appears to be expanding to some extent in areas where the market price of heavy petroleum fuels is depressed either by an over-supply or by the competitive influences of coal and natural gas. In this operation, the residual stocks otherwise suitable for use only as heavy fuel are decomposed thermally to produce gas, gasoline, and distillate fuels, along with an unavoidable residue of coke. The distillate fuels are used either as furnace oils or as charge stock to cracking units.

Catalytic cracking. Catalytic cracking is similar to thermal cracking in that it converts fuel oil into gasoline. The use of a catalyst, usually activated clay or a synthetic silica alumina, results in high yields of high octane number gasoline without the production of low-value heavy fuel oil which is always a product of thermal cracking. On the debit side are high investment and operating costs per barrel of product.

Initially, catalytic cracking was confined to the use of light distillate charge stocks. More recently, heavier distillates and even de-asphalted residual stocks have been used. Further developments in the field of cracking residual crude and other residual stocks are now underway, but these stocks deposit salts and a large amount of coke on the catalyst, and these disadvantages must be weighed against the advantages of the catalytic processing over thermal processing. No residual stocks are yielded in the catalytic operation, since all material that is incapable of being distilled from the catalyst at the high operating temperatures (850-950° F.) (450-510° C.) will be burned in the catalytic regeneration step.

The higher anti-knock quality of the gasoline resulting from catalytic cracking over that from thermal cracking results from the effectiveness of the catalysts in causing cyclization and some isomerization to produce aromatics, naphthenes, and isoparaffins, rather than the predominating dehydrogenation to form olefins that occurs in the thermal cracking operation. The isomerizing action is most noticeable in the lighter fractions, and advantage can be obtained by alkylation of the isobutane which is

formed together with light olefins in the cracking operation.

Although catalytic cracking in the form of the Houdry process was commercially introduced in 1936, it did not become an appreciable factor in gasoline production until the war years, during which time catalytic charge capacity was increased to nearly 1 million barrels per day. During the war years the bulk of catalytically cracked gasoline went into the production of Grade 100/130 aviation fuel. In 1945, the composite of U. S. production of this high-quality combat grade of aviation fuel contained nearly one-third catalytically cracked stocks.

Figure 7 indicates the extent to which catalytically cracked stocks are replacing and supplementing thermally cracked stocks in motor gasoline production in the U. S. The installation of catalytic cracking equipment has been constantly expanding since the war until the charge capacity is now approximately 1.5 million barrels.

Polymerization. In thermal cracking, thermal re-forming, and catalytic cracking, degradation products consisting partly of gaseous materials are formed. These include substantial quantities of butylenes and propylenes which cannot be incorporated into the gasoline because of vapor pressure limitations. In order to produce more gasoline and improve further the anti-knock quality, catalytic polymerization techniques were developed during the 1930s, and applied to recover these olefinic constituents. Sulfuric acid or phosphoric acid is used as the catalyst.

Over-all, polymer gasoline represents only a very small portion of total gasoline production in current operations. The capital cost involved in its installation, is, however, relatively small, and polymer units are becoming more and more profitable adjuncts to catalytic cracking to supplement over-all quantity and quality of the gasoline produced. Although polymer gasoline has an anti-knock quality in the range of high octane number aviation fuels, it cannot be used for this purpose because of its olefinic character and resulting relative instability. Where an aviation fuel component is desired, the polymer must be hydrogenated to give a saturated product.

Alkylation and isomerization. Alkylation was developed in the mid-1930s. This process initially involved the combination of isobutane with butylenes at low temperatures (30-60° F.) (—1 to + 16° C.) using sulfuric acid as a catalyst. In the early 1940s, hydrofluoric acid catalyzed alkylation was applied in commercial practice. The product from butylene alkylation consists primarily if iso-octanes which are well known for their high anti-knock quality. Subsequently, propylene and amylene were found to be suitable olefin feed components to produce other isomeric aliphatics of slightly lower octane number. Alkylate is a saturated stable gasoline stock, and is an ideal component for high octane number aviation gasoline.

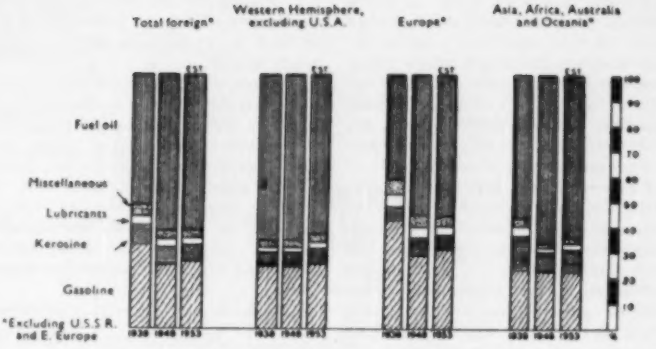


Figure 4. Foreign Petroleum Product Distribution.

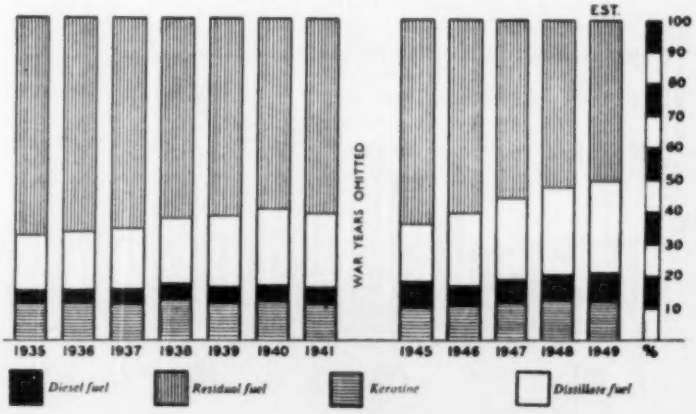
Alkylation is a more expensive process from the investment and operating standpoints than is polymerization. As a result of war-time requirements, alkylation capacity was expanded to about 150,000 barrels per day. Since the war, much of this capacity has been operated to produce gasoline for automotive use, but the installation of new units for this purpose appears to be questionable on the basis of economics.

Processes for the alkylation of isobutane with ethylene have been developed, but commercial application has been retarded by high installation and operating costs, particularly those involved in ethylene recovery. Aluminum chloride and aluminum bromide have been found to be effective catalysts. The principal component produced is di-isopropyl (2,3-dimethyl butane). It is characterized by extremely high anti-knock quality and is far superior to iso-octane when used to operate aircraft engines under rich mixture conditions.

Although catalytic cracking produces a sizeable quantity of isobutane, the expanded alkylation facilities constructed during World War II could not have been filled had not butane isomerization been practiced commercially. This process uses aluminum chloride as a catalyst with anhydrous hydrochloric acid as a promoter. Conversion is accomplished at relatively low temperatures and pressures and with high yields. Installed capacity ultimately exceeded 30,000 barrels per day of isobutane, much of which has been converted to other types of operation.

Isomerization of other light gasoline fractions, including pentane, hexane, and heptane, has also been accomplished commercially. This reaction is carried out in the liquid phase, and the catalyst employed is an aluminum chloride-hy-

Figure 5. Relative Production of Fuel Oils in the U. S.



drocarbon complex, using hydrogen chloride as a promoter and hydrogen as a cracking suppresser. Again, improvements in anti-knock quality are effected and product yield is high, generally of the order of 95 percent. Some quantities of these materials from this source were used in the aviation gasoline program during World War II.

Polyforming and hydroforming. Two other significant gasoline-producing processes were installed in refineries during the late 1930s: polyforming and hydroforming. Both of these refining techniques utilize mainly low octane number gasoline fractions as a feed stock and produce reformed gasolines of higher anti-knock quality than conventional reforming.

Polyforming is a thermal process but utilizes propane, propylene, butane, and butylene, in addition to heavy naphtha, as a charge stock. The gaseous components of the charge which might otherwise be refinery fuel are converted—polymerized—to a substantial degree in the processing to gasoline. The nominal capacity in operation in 1949 was 70,000 barrels per day.

Hydroforming requires the use of a catalyst and hydrogen recycle. In addition to producing a high octane number gasoline—arising largely from aromatization of the feed—this process desulfurizes the feed stock by depositing most of the sulfur on the catalyst. This is oxidized to sulfur dioxide during the catalyst regeneration step, and rejected from the system. Hydroforming is, therefore, of particular value in processing high-sulfur naphthas to improve their susceptibility to tetra-ethyl lead, as well as to improve inherent anti-knock quality.

Hydroforming, because of its attribute of aromatization, found its principal application during the war in producing the enormous quantities of toluene required for explosives manufacture. Some of this capacity is still being used to produce aromatic solvents and toluene for use as a chemical intermediate. Nominal capacity for hydroforming operations was 85,000 barrels per day in 1949.

Gasoline treating. The refining techniques that have been adopted to make more gasoline of a higher-quality level out of crude petroleum, have had a secondary effect upon the industry in requiring additional treating steps to make some of these products more effective from the utilization standpoint, and more acceptable from the marketing standpoint. Such treating falls into three broad classifications:

1) Stability improvement to prevent formation of gummy constituents in storage and during use.

2) Conversion, for marketing reasons, of malodorous sulfur compounds to compounds having no odor.

3) Removal of sulfur compounds to improve odor and susceptibility to tetra-ethyl lead.

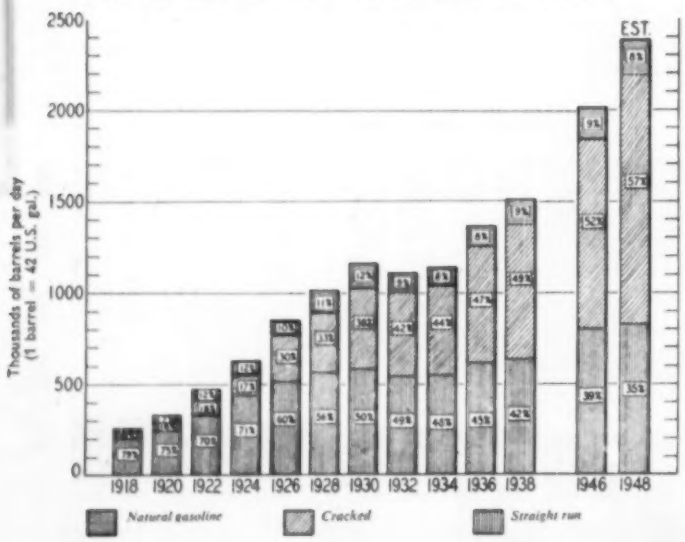
Stability of gasoline distilled directly from crude petroleum offers no problem. The components are saturated paraffins, naphthenes, and aromatics, which are relatively unreactive with each other and with oxygen of the air under storage and handling conditions. On the other hand, gasolines obtained by the decomposition of heavier hydrocarbons by conventional thermal or catalytic cracking may contain varying amounts of olefins, diolefins, active sulfur compounds, and small quantities of oxygenated compounds (phenolic type), which may react with each other or may be oxidized by air during storage or in automotive fuel supply systems. In years past, many thermally cracked motor fuels were treated either with clay or acid to remove the most active components which would tend to form gum. These procedures, which are costly in terms of both operating costs and product yield, are rarely practiced today except in the cases of gasolines obtained by the most severe cracking techniques. Most effective oxidation and gum inhibitors have been developed, which accomplish the same results as chemical treating at a much lower cost and at no loss in yield. These inhibitors, a number of which are available, are generally effective in concentrations less than 0.005 percent in the average gasoline blend.

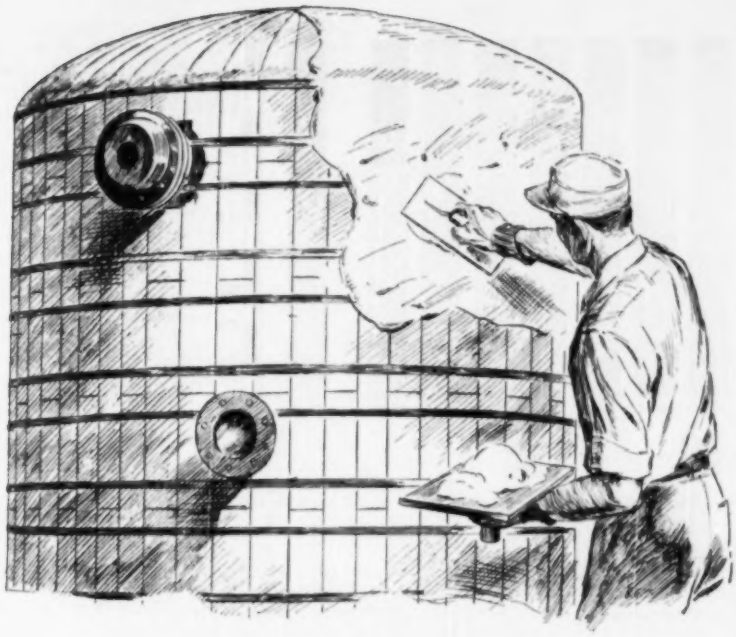
Aviation gasoline specifications impose more restrictive stability requirements than do motor gasoline specifications. The most effective oxidation and gum inhibitor is not sufficient in the maximum quantity allowed (generally 0.003 percent) to limit gum formation in the majority of catalytically cracked stocks to the limits imposed by the specifications. Three procedures were established during the war to make such stocks satisfactory: sulfuric acid treating, mild hydrogenation, and re-treating in the vapor phase in the catalytic cracking unit. All have the advantage of further enhancing anti-knock quality. Catalytic treating was used most extensively, but it had the disadvantage of using equipment-time which might otherwise be utilized in the more profitable cracking operation.

Removal of light malodorous mercaptan sulfur compounds by caustic washing, and conversion of mercaptan sulfur to disulfides by the Doctor technique using litharge, caustic, and sodium hypochlorite have been practiced for many years. More recent procedures accomplishing the same conversion utilize lead sulfide and copper chloride.

The disulfides formed in the above conversion treatments remain in the gasoline, and reduce the effectiveness of tetra-ethyl lead in improving the octane number. Consequently, more emphasis is now placed upon removal of the mercaptans from the gasoline. Various solvent extraction techniques are currently practiced in which various materials are added to caustic solutions to enhance

Figure 6. Consumption of Motor Fuel in the U. S. Showing Expansion of Cracking.

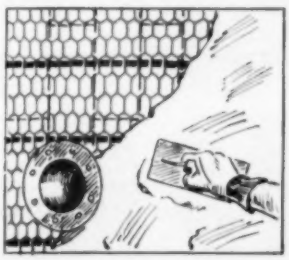




What's wrong with this picture?

Here is a workman applying cement finish over the insulation on a boiler water heater, but he has omitted one very important step. For a good job, a layer of hexagonal wire mesh should have been placed over the insulation before the cement finish was applied. Here's why this is important.

Over very small areas, insulating cements will adhere well enough to heat insulating materials. But on larger equipment and fittings, even though some key is afforded by bands or wires that hold the insulation in place, this is far from sufficient to anchor the finish for any length of time. A layer of wire mesh provides the key necessary for a tight job. It also distributes evenly the effects of expansion and contraction after the equipment goes into operation, thus reducing cracks in the finish.



The wire mesh over insulation on larger size equipment is just an example of how unseen details can add to the efficiency and life of a heat insulation job. Being sure every detail, both seen and hidden, is done right is one of the things you can count on when you hire a reliable contractor. Armstrong has established a reputation for reliable workmanship, and close attention to detail.

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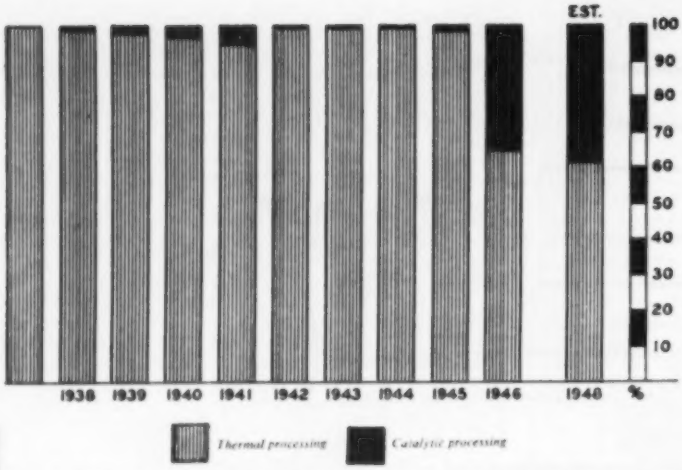


Figure 7. Relative Production of Cracked Motor Gasolines in the U. S. (All thermally cracked previous to 1938.)

their extraction efficiencies. The better known are the Tannin-Solutizer and the Unisol processes. The former uses potassium or sodium hydroxide fortified with cresylic acids (usually recovered from the gasoline streams to be treated) and with tannin which acts as a catalyst in the regeneration of the solution. The Unisol process uses sodium hydroxide and methyl alcohol. The solutizer solution in each instance extracts the mercaptans from the gasoline stock. In Tannin-Solutizer, the mercaptans are oxidized to disulfides in the extract, from which they may be withdrawn from the treating system and the solutizer solution recirculated. In Unisol, the mercaptans are stripped from the treating solution by distillation, and settled from the methanol by dilution with water.

Where a gasoline stock of high sulfur content is encountered, resort may be taken to sulfuric acid treatment. This is not widely practiced, since yields are affected adversely, particularly with cracked fuels.

Effect on fuel oils. With the inception of new processes for the production of greater quantities of gasoline there have, of course, been corresponding changes in the character and source of most fuel oil distillates and residuals. One exception is kerosine. The restrictive specifications for this product, particularly the lamp burning test generally required, limit it largely to a highly paraffinic fraction distilled directly from crude.

Figure 8 illustrates an estimated distribution of the source of both distillate and residual fuel oils from a refinery typical of several periods over the past 40 years. The proportion of straight-run product in total distillate fuel is rapidly decreasing. The straight-run distillates provide ideal charging stock for catalytic cracking units inasmuch as the gasoline yields are higher with straight-run distillates than they are with cracked distillates. Straight-run residual materials are replacing distillates as charge stock to thermal cracking units, and more residuals are being de-asphalted for charge to catalytic cracking units.

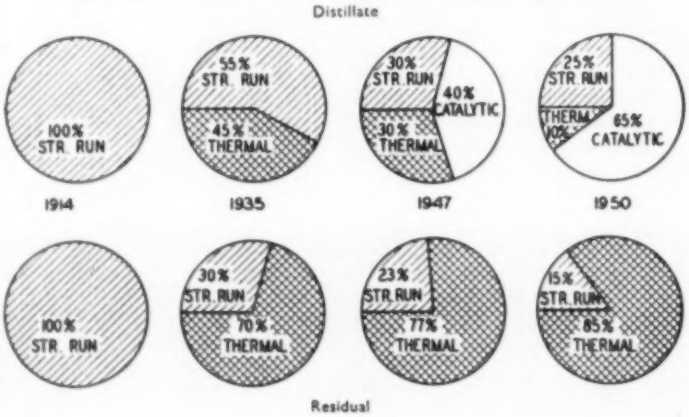
The proportion of thermally cracked distillate fractions is also shown to be decreasing. The most significant reason for this is, of course, the expansion of the installation of catalytic cracking operations in preference to thermal cracking. Large quantities of thermal distillate are either recycled to extinction in thermal units, or used to supplement straight-run distillates for charge to catalytic cracking units. Thermal cracking operations are being restricted largely by viscosity-breaking heavy residual stocks. In this case, the yield of distillate fuel is not very large and is usually used for catalytic cracking charge.

Over the span of years covered by the chart in Figure 5, there have been marked changes in the hydrocarbon composition of distillate fuels. These have little significance in those applications which demand the largest volumes in America, such as steam generation and household heating, where the fuel is atomized and mixed with air prior to combustion and where ignition quality, per se, is not a factor. These changes may be important, however, in vaporizing-type household heating equipment and in diesel engine applications where high ignition quality or cetane number is required.

Cracked fuels, either from thermal or catalytic processing, are characterized by a higher carbon to hydrogen ratio than exists in the fuel oil charge stock from which they are derived. This results, of course, from the dehydrogenation during the cracking of paraffins and naphthenes to olefins and aromatics, respectively.

It is well established that paraffins, with their low carbon to hydrogen ratio, give best performance in the more critical types of vaporizing-type space heaters, in kerosine lamps, and in other applications developed around kerosine as a fuel. Paraffins, likewise, have the higher ignition quality—cetane number—in the distillate fuel oil range. Other than cetane number, catalytically cracked distillates have been found to be good diesel fuels, since olefin concentration is relatively low and stability problems have not been found to be significant.[1] Although catalytic distillate has a lower cetane number than the corresponding straight-run distillate from the same

Figure 8. Estimated Distribution of Stocks in Fuel Oils for Prototype Refineries.



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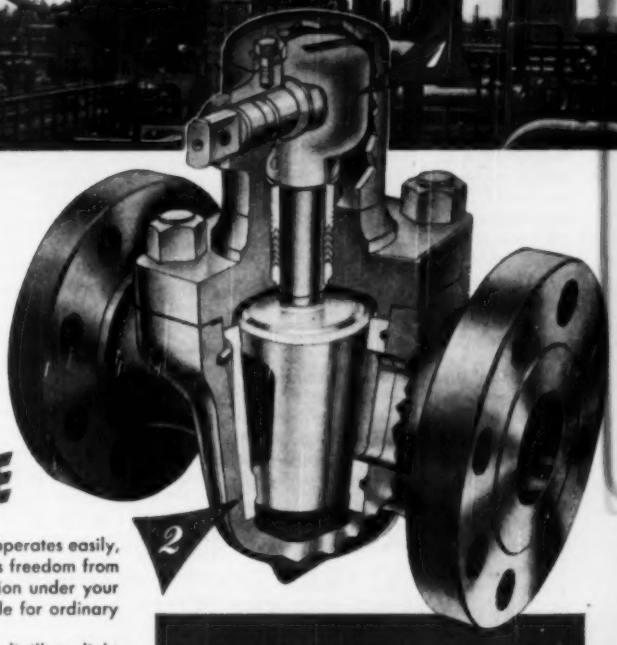

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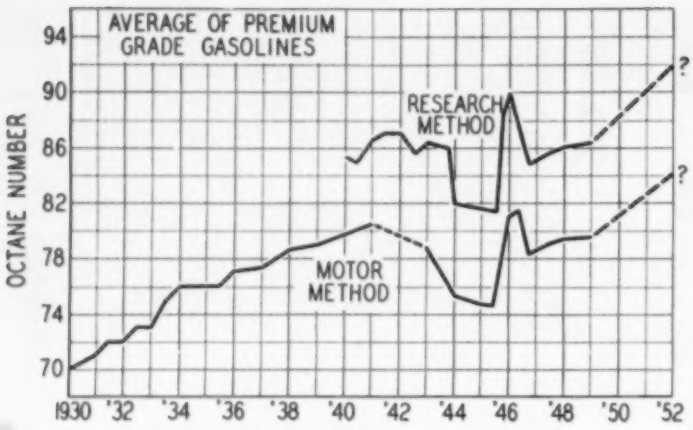


Figure 9. Trends in Anti-Knock Quality of U. S. Motor Fuels.

grude, the utilization of catalytic stocks in diesel fuel is expected to increase greatly. The basis for this expanded use is twofold; first, catalytic distillates or blends with straight-run will be available much more widely, and second, the utilization of fuel oil stocks—which will consist of or contain catalytic distillate—will give the diesel equipment operator product lower in cost than a specifically segregated, lower volume fuel, intended for diesel use only. Diesel engine manufacturers in the U. S. have recognized this trend and are designing their engines to operate satisfactorily on the lower cetane number fuels. Foremost in this effort are the builders of railroad diesel engines. In this redesign, advantage is being taken of the significantly higher volumetric heating value of the catalytic fuel oils.

Trends in Motor Gasoline Utilization

Quality demands. Figures 9 and 10 show the trends since 1930 in the anti-knock quality of the regular and premium grade gasolines sold in the U. S. In connection with these data it should be noted that the Research octane number is now more widely accepted than the Motor octane number, as a better indication of gasoline quality in vehicles on the road. Whereas there is little difference between the anti-knock values obtained by these two procedures on straight-run gasolines, differences become increasingly greater with increased olefin and aromatic content of the motor fuel. Thus, thermally cracked and catalytically cracked fuels may have Research octane numbers from 8 to 12 units higher than their Motor octane numbers. American automotive engine builders are beginning to appreciate the improved fuel-engine performance that can be realized by designing in the direction of mild engine operating conditions such as are used in rating fuels by the Research method. Such design makes it possible to get the most out of the sensitive fuels which will be the type available in the foreseeable future.

The data in Figures 9 and 10 indicate a constant upward trend, except during the war years, when high-quality stocks and tetra-ethyl lead went to military gasoline, and during the period 1946 to 1948 when tetra-ethyl lead was in short supply. From this information and expenditures on refinery equipment during the war, some basic figures may be cited on the cost of increased anti-knock quality.

The extensive installation of catalytic cracking and associated facilities during the war years to meet high octane number aviation fuel requirements cost the refining industry nearly $900 million. Between 1941 and 1946, the anti-knock quality of regular and premium grades increased barely three octane numbers, in spite of the fact that aviation fuel production had almost entirely been converted to motor gasoline in 1946. By simple division, this would indicate that an increase in over-all fuel anti-knock quality of one octane number did cost $300 million at that time. In the interim period, construction costs have nearly doubled.

In spite of the high investments necessary, the anti-knock quality of motor fuels as marketed in the U. S. is increasing. This situation may be attributed to two factors: 1) the competitive spirit in the petroleum industry, and 2) recent developments in automotive design. In the immediate post-war period, refiners, contrary to expectations, were hard pressed to meet volume demands for both gasoline and fuel oils. Such a situation was not conducive to upgrading gasoline quality, which could be accomplished only through reducing refinery throughput, together with some over-all loss in total saleable products. A number of factors, including refinery expansion, a mild winter in north-east U. S., a shipping strike, and general saturation in industrial fuel demands, alleviated the tight supply situation early in 1949, and the anti-knock quality of gasolines began to increase almost immediately. Such was the competitive influence.

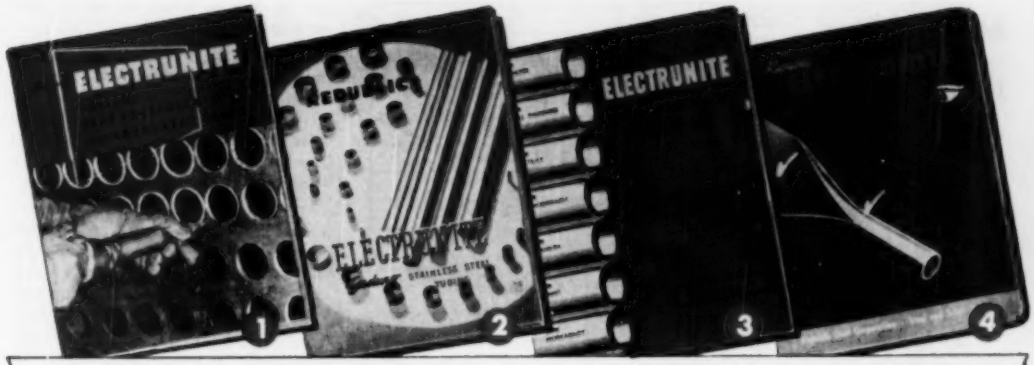
Supplementing this was the fact that the largest passenger car manufacturer in the world announced in 1947 that he had succeeded in designing an engine which could be produced on a production line basis into which it was possible to incorporate compression ratios as high as 12/1. "With this compression ratio, it was stated that fuel economy could be increased as much as 35 percent over an engine designed before the war having a compression ratio of 6.5/1. Disregarding the fact that a 100 + Research octane number fuel would be required, this is indeed an attractive development.

In connection with this development, fuel tests have been run in cars fitted with research engines of this design having compression ratios of 8/1, 10/1, and 12.5/1. Data from these tests are presented in Figure 11 as plots of low speed road ratings versus Research octane number. Presented in this chart are results[3] on 44 fuels as obtained by the laboratories of three petroleum companies in cooperation with the automobile manufacturer.

The data in Figure 11 indicate the general octane number level required to give knock-free performance in these high compression ratio cars. For the 8/1 compression ratio, the requirement range is about 90 to 95 Research octane number; for the 10/1, about 95 to 100; and for the 12.5/1 car, about 100 octane number to iso-octane + 0.5 ml. tel./gallon.

It may also be seen in Figure 11 that there is a general relationship between Research octane number and the performance of the fuels at low speed in the high compression ratio cars. For the most part, the average road ratings obtained in two 8/1 cars are one to two octane numbers lower than the Research ratings. In contrast, average road ratings obtained in the 12.5/1 and 10/1 cars are about two octane numbers higher than the corresponding Research ratings. These results illustrate two principal points: 1) by proper automotive engine design, advantage can be taken of the higher Research octane number of commercial motor gasolines, and 2) if automotive engine design follows this trend, the Research octane number of motor gasolines will, in itself, constitute the essential measure of anti-knock quality.

In order to approach the high-quality



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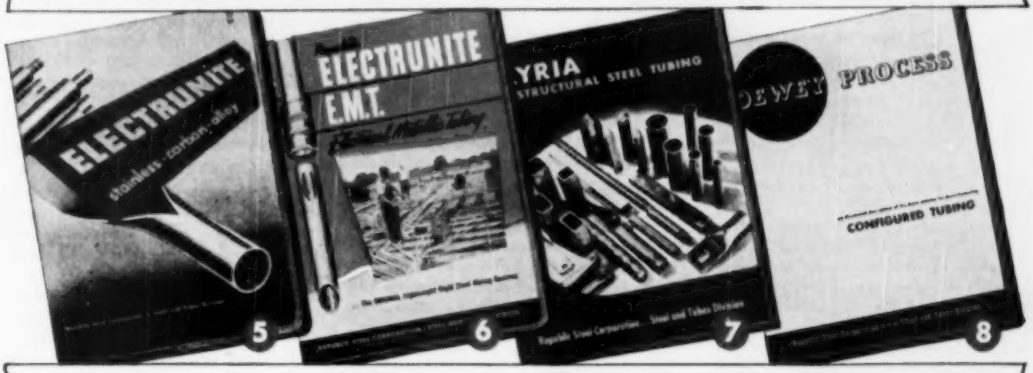

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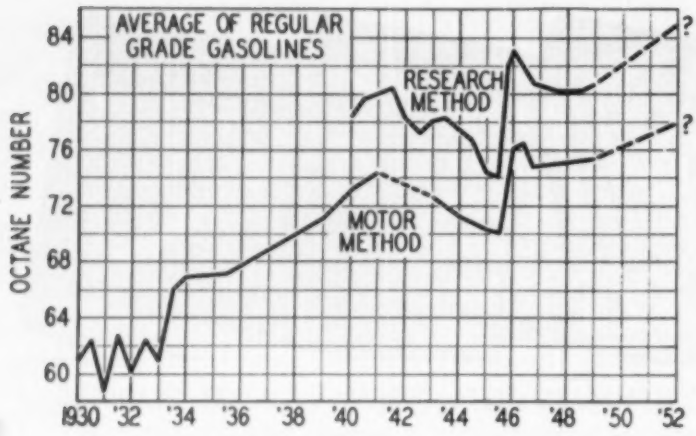


Figure 10. Trends in Anti-Knock Quality of U. S. Motor Fuels.

levels demanded by the 10/1 and 12/1 engines, it is recognized that the result will be high processing costs and increased consumption of liquid petroleum to produce the same volume of gasoline. Consequently, before considering future advances in refining that will make this possible, consideration must be given to the efficiency with which octane numbers are currently utilized and steps that can be taken by motor car manufacturers to improve the efficiency of utilization.

Utilization efficiencies. Utilization efficiency of fuels in the transportation fields is extremely low when compared to the other two broad fields of energy utilization — domestic and commercial heating and industrial heat and power. Defining thermal efficiency as the ratio of the net usable energy output arising from a fuel in a given application to the total fuel energy input, over-all efficiencies under actual load conditions in the three main fields of energy utilization are domestic and commercial heating, 60 percent; industrial heat and power, 38 percent; and transportation, 5 percent. These figures are based upon the current relative use of all fuels, including coal, gas, and petroleum fuels. Segregating gasoline use in the transportation field, the efficiency of utilization is found to be nearer 6 percent. It would appear, therefore, that automotive equipment offers a most fertile field for improvement.

Increasing compression ratio of automotive engines to improve efficiency has been a popular route that American engine builders have followed. Relatively speaking, gains to be anticipated by this procedure are small. A compression ratio increase to 12.5/1 from the current average of 6.7/1 would raise the over-all efficiency from 6 percent to slightly over 8 percent. To accomplish this, it would appear that octane numbers in the range of 100+ would be required, an increase of about 10 units above the level of the best premium grade motor fuels available in America today. Besides requiring a substantial investment in processing equipment on the part of the petroleum industry, energy requirements to process lower octane number fractions to the high range may well offset a substantial portion of the increased efficiency obtained in increasing compression ratio, as will be discussed later. These factors would be reflected in fuel cost, and may result in an overall economic loss to the motoring public in following such a route.

Alternative procedures for improving the efficiency of automotive equipment should receive detailed study. These alternatives do not require significantly higher octane number fuels but, instead, are based on more effective utilization of anti-knock quality currently available. The latitude for improvement in this respect is apparent in the analysis of Figure 12, which plots octane number requirements of a popular American car against the load at various speeds. A fuel of about 80 octane number is required to give knock-free performance under full-load conditions at speeds between 20 and 40 miles per hour. On the other hand, the peak octane number requirement under road load conditions is less than 35 at 60 miles per hour and below zero at speeds less than 40 miles per hour. Considering the relative amount of time—usually less than 10 percent in passenger vehicles—that full power is required, these data serve to demonstrate the waste of anti-knock quality when it is considered that an 80 octane number fuel is used 100 percent of the time in this car solely to satisfy peak requirement.

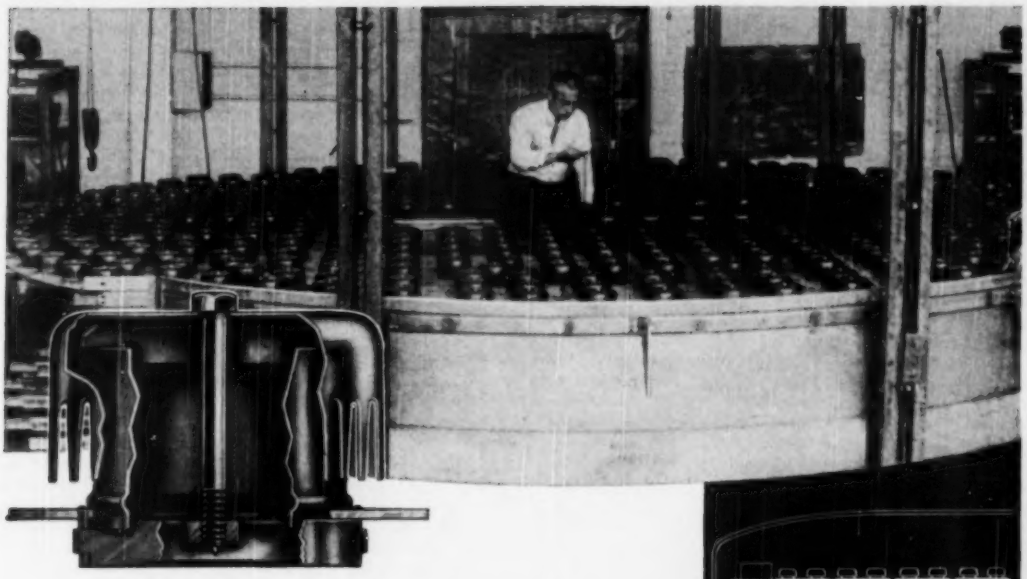
An alternative to increasing compression ratio is the application of supercharging. Supercharging may be applied in several ways to effect improvements in economy although, heretofore, it has been used almost exclusively to develop increased power.

One means for improving economy is the use of a smaller engine which would operate unsurpercharged in meeting normal part load requirements, and supercharged to meet high power demands. In such an installation the engine would operate at a high load factor for a greater portion of the time than does the conventional engine. This approach would result in a higher octane number requirement as compared to the larger unsupercharged engine. However, for a given improvement in fuel enonomy, the increase in anti-knock quality requirement would be less than that for the same improvement in economy obtained by a higher compression ratio. It is assumed, of course, that some provision is made for aftercooling.

A more recent proposal is based upon the use of a small continuously supercharged engine, using aftercooling, and the recovery of the exhaust gas energy in a gas turbine geared to the engine. In effect, this approach gives the higher efficiency obtainable at a high compression ratio without the high octane number requirement associated with an increase in compression ratio. This approach, as well as the previous one, is sound in theory, but does present some difficult engineering problems if the cost of the installation is not to be prohibitive.

Even greater gains in fuel economy than are obtainable by higher compression ratios and supercharging can be achieved by the development of an automatic transmission, which changes the speed ratio between the engine and the driving wheels in order to give the optimum combination of engine speed and thermal efficiency. In practice, such a transmission would function to give engine operation at or near full load all of the time, with the drive wheel output being very nearly a direct function of engine speed. Supplementing the higher efficiency resulting from operation near full load would be the decrease in engine friction resulting from an overall reduction in average engine speed. With this application, currently being accomplished to a small degree by a single-stage overdrive, relatively small increases would be encountered in octane number requirement.

In America the most significant factor in the low efficiency of the passenger car arises from the fact that the motoring public desires peak performance and



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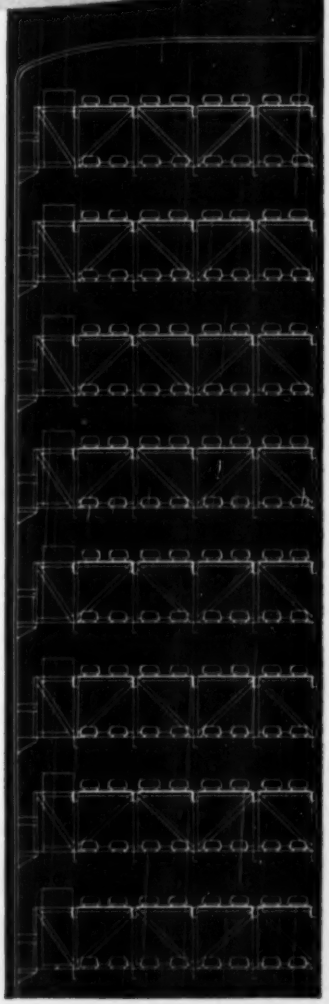

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comfort. Cars must be sufficiently powered for high speeds and rapid acceleration to be acceptable to the car operator, although the engine will be producing power equivalent to less than ¼-load, with accompanying high energy losses for a majority of its operating time. To provide comfortable riding cars, car weights will vary from about 3000 pounds for the lower price group to well over 4000 pounds for the more expensive makes. These two factors have contributed largely to the fact that although engine efficiencies have been increased about 30 percent in the past 20 years, cars manufactured today give about the same miles per gallon as did models in 1930.

Only operating cost, largely in terms of fuel, can change the attitude of the motoring public on performance and comfort requirements. Trends in the design of foreign cars have demonstrated that where fuel costs are high, economy of operation has considerable influence. As fuel costs increase in America, and there is every indication that they will, with exploration, drilling, recovery, and refining costs increasing, there will be a greater demand for more efficient vehicles at the expense of performance and comfort, and there will be a greater incentive for engine and transmission redesign to effect improved economy. Table 1 summarizes the increased mileage obtainable per gallon of fuel under road load conditions with various changes in engine transmission and vehicle design.[8]

The reciprocating aircraft engine constitutes the only other significant field of gasoline utilization. Here there seems to be little promise for any marked improvement in efficiency. Supercharging provides the high compression pressures which would lead to improved efficiency in the automotive engine. Also, the aircraft unit operates at relatively high load factors all of the time. Some improvements may be forthcoming in turbine compounding, but these would be relatively minor with reference to their effect on the over-all efficiency of the unit.

TABLE 1
Increase in mileage obtainable by design modifications

Design Modification	Increase in Mileage %
Overdrive	13
Lower wind resistance	8
Weight Reduction (15 percent):	
Smaller engine	16
Axle ratio change	10
12/1 Compression Ratio:	
Smaller engine	30
Axle ratio change	38
Supercharging:	
Smaller engine	17
Axle ratio change	17
Automatic transmission	37
More accurate carburetor metering	5-50
Reduction of heat loss and incomplete combustion	10-40

Turbo-jet equipment and "prop" (propeller) jets will probably use gasoline fractions as a portion of their fuel. These units are still in the process of evolution and promise to give higher efficiencies than are currently obtainable. The primary need here is for the development of materials and methods which will allow the use of higher temperatures and pressures.

Future Processing Techniques

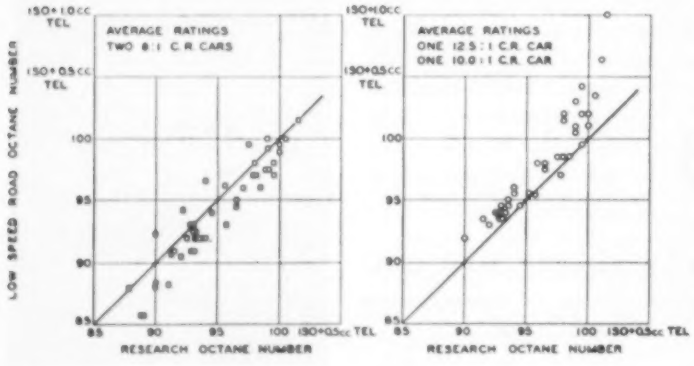
United States. To increase the production of gasoline and distillate fuels, installation of coking units and other means of converting residual stocks, and installation of catalytic cracking equipment to process the distillates so obtained will continue. Catalytic units are now being built in sizes ranging from 2500 to 40,000 barrels of charge capacity per day. Development of the design of the smaller units, to reduce their investment and operating costs, is expected. Auxiliary polymerization facilities of some types are generally considered essential to convert excess butylenes and propylenes to gasoline, thus improving over-all yield and quality.

The combination of catalytic cracking and polymerization is, however, insufficient to reach the octane levels that are anticipated sometime in the future. The desired increases in octane number will have to be obtained by reforming straight-run gasoline stocks, either thermally, or, at the higher levels, catalytically. Hydroforming, the only widely used catalytic reforming process, is very effective but, as has been indicated, investment and operating costs are high. A number of factors contribute to this —the recycling of hydrogen under high pressure, a relatively expensive catalyst, alternate on-stream and regeneration of catalyst, etc. In the field of refining for the production of gasoline, more time, money, and manpower is currently being put into research and development of reforming techniques than any other single type of processing. The goal is lower installation costs by adapting truly continuous operation using lower pressures, and more specific catalysts with greater activity and lower cost. Hydrogen recycle will undoubtedly continue to be necessary to retain the desulfurization characteristics which are so attractive in conventional hydroforming and to realize the high yields compared to conventional thermal reforming.

The path to greater yields of higher octane number motor gasoline is not a simple or inexpensive one. The past 10 years have seen a marked increase in manpower—five times—and in money—ten times—poured into research and development activities in the petroleum industry. At the present time the U. S. petroleum industry is spending more than $100 million every year on research and development work directed in large part to establishing better and cheaper ways of producing higher-quality gasoline.

As a further indication of the costs involved in obtaining high octane number gasoline, data on gasoline yields, equipment costs, and fuel requirements representing a sequence of refinery operating plans which might be employed to produce gasoline at varying octane number ratings, are shown in Figure 13. The simplest refinery, of course, would use only distillation, and would produce about 30 percent of 65 octane number gasoline from a typical Mid-Continent crude. The heating value of the fuel used would be 9 percent of the heating value of the gasoline produced, and the cost of a 100,000-barrel-per-day refinery, complete with all auxiliaries, would be $33 million. The installation of catalytic cracking, vis-breaking, and polymerization as means of converting fuel oils to gasoline—a total of 56 percent would be obtained—would raise the octane number level to 80, the plant cost to $62

Figure 11. Fuel Ratings in High-Compression Ratio Cars.



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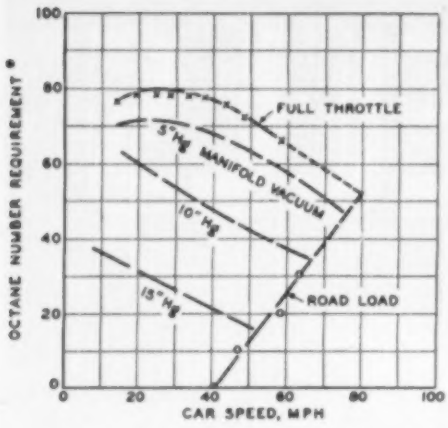

Figure 12. Octane Number Requirements of a 7 0/1 Compression Ratio 8-Cylinder, 1946 Automobile. (*Based on very light knock, level road operation, primary reference fuels.)

million and the fuel requirements to 15 percent based upon the gasoline produced. Subsequent octane number increases must be obtained by re-forming of ever-increasing severity and extent. Re-forming to 96 octane number, the limit considered here, would convert gasoline stocks to fuel gas and tar to the extent that the gasoline yield would be reduced to 43 percent, while the plant cost would climb to $91 million and the fuel use to 29 percent. It can be seen from the shape of the curves in Figure 13 that the higher octane numbers are extremely expensive on all counts.

Such is the situation today and the probable future trend in gasoline production in the U. S. The octane numbers of the better gasolines currently being marketed are several units above the level of their pre-war counterparts. The competitive situation and automotive engine requirements have joined forces to increase anti-knock quality further. The rate of increase will probably be slow, since huge investments will be required for new equipment to attain these higher levels. Research and development of new re-forming techniques and catalysts can, and probably will, make this task less expensive, but will take some time to accomplish.

When more efficient and more effective re-forming processes are developed, their installation outside of the United States should be most attractive. Unlike thermal and catalytic cracking, they will not convert potential fuel oil, which is so highly desired now and in the foreseeable future, to gasoline, but will serve to increase the octane number of present-day motor fuels.

Fuel oil processing will change to a certain degree, although the major change will result from the trend away from thermal cracking to catalytic cracking for the production of motor gasolines. As a result of this shift in gasoline-producing operations, distillate fuel oils for domestic heating, diesels, and certain industrial uses will consist for the most part of catalytic and straight-run stocks with relatively little thermal product. Residual fuel oil production may also change somewhat, the cause for change being the reduction in relative demand for heavy residuals, effected in large part by higher crude runs to meet gasoline and distillate fuel oil demand, and by the increasing availability of low-cost natural gas. A number of processing techniques are available to reduce residual fuel oil production, including vacuum distillation, vis-breaking, and coking. By resorting to these operations, increased quantities of distillate fuel or charge stock for catalytic cracking to produce gasoline are made available. Once again, the controlling factors will be economic conditions and the highly competitive situation which exists in the U. S. petroleum industry.

Europe. It has been pointed out that gasoline is the prime product in North America and, within the next few years, it is anticipated that the gasoline yield from crude petroleum will increase from the present level of 40 percent to the range of 45 to 50 percent. Total fuel oil production, including both distillate and residual fuels, is likewise in the range of 45 to 50 percent in the U. S.

In Europe and in other parts of the world, economic considerations and the compelling primary demand for fuel oil have not been conducive to the adoption of the more advanced refining techniques used in the U. S. The relative usage of petroleum products in Europe and the U. S. gives some measure of how much the petroleum industry, overall, must expand outside the U. S. in order to have parallel conditions. In Europe, excluding U.S.S.R., petroleum consumption is approximately 0.65 barrel per person per year. In the U. S., on the other hand, consumption per person is about 12 barrels per year. With reference to gasoline, these figures are approximately 0.19 barrel for Europe, and 5 barrels for the U. S.

It is apparent from these figures that the primary fuel oil requirements of industrial areas such as Europe are far from being met, if the economies are to approach American standards. Consequently, it would appear to be some time before the conversion of fuel oil fractions to gasoline will be practiced to any great extent outside of the U. S.

This conclusion does not preclude certain types of processing which will improve the anti-knock quality of gasolines. Thermal re-forming is currently being practiced in some quarters, and expansions of this technique are under way. It can, therefore, be expected that if catalytic re-forming methods should be developed which are more economical from the investment, operating, and yield standpoints, they should be readily adaptable to operations in those countries whose economy is based on fuel oil. Where re-forming is practiced, be it thermal or catalytic, it is probable that polymerization will be a profitable supplementary operation.

Without extensive thermal or catalytic cracking of residual fuel oils, gasoline treating will not be a particularly difficult problem. In those cases, however, where straight-run gasoline fractions and re-formed fractions do contain appreciable quantities of mercaptan sulfur, extraction processes for its removal will probably be profitable to install. This has been the case in several recent instances.

Assuming that the European countries will draw largely upon Near East crude sources for petroleum supplies, high-quality kerosines and fuel oils will be readily available. One possible exception involves sulfur content. In general, it is believed that rather simple acid treatment will be sufficient to reduce sulfur content of kerosines where this property is most vexing. From the ignition quality standpoint, distillate fuels from Near East crudes should be ideal for diesel engine application.

REFERENCES

[1] Aplohn, T. L., and Nelson, F. L., Diesel Fuels From Catalytic Cracking Operations. *Pet. Ref.* 27, No. 7, (1948).

[2] Symposium on Relationship of Fuel Properties to Engine Design and Future of High Octane Fuels. *Amer. Chem. Soc.*, St. Louis, Mo., (Sept., 1948) and unpublished reports of Socony-Vacuum Laboratories.

[3] James, W. S., Some Factors in Gasoline Economy. *S. A. E. Quar. Trans.* (1949) No. 2, (July).

[4] Research rating with 1 ml. of tetra-ethyl lead per gallon.

BIBLIOGRAPHY

Thermal Cracking and Re-forming
Sachanen, A. N. *Conversion of Petroleum.*

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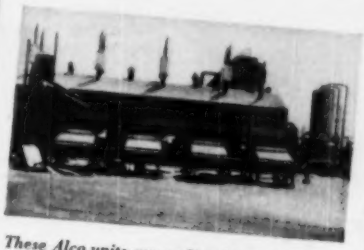

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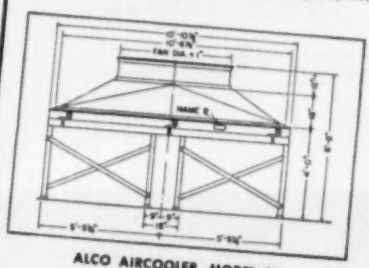

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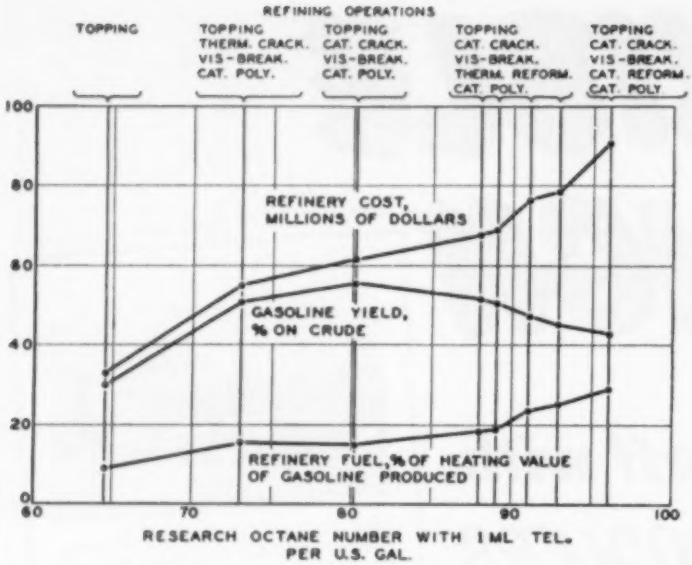


Figure 13. Relation between Octane Number and Gasoline Yield, Fuel Requirements, and cost of a 100,000-barrel-per-day Refinery.

Reinhold Publishing Co., New York.

Armistead, G. The Coking of Hydrocarbon Oils. *Oil and Gas Journ.* 44, No. 45. (1946).

Feuchter, C. E. Economics of Thermal Reforming. *Oil and Gas Journ.* 48, No. 11. (1949).

Nelson, E. F. Platforming—a New Catalytic Re-forming Process for Improving Straight-Run and Natural Gasoline. *Oil and Gas Journ.* 47, No. 19. (1948).

Catalytic Cracking

Simpson, T. P., and others. Recent Developments in TCC Processing. *Proc. Amer. Pet. Inst.* 24, Section III. (1943).

Noll, H. D., and others. Simplicity and Flexibility of Thermofor Catalytic Cracking. *Pet. Ref.* 25, No. 5. (1946).

Murphree, E. V., and others. Fluid Catalyst Process. *Indus. and Eng. Chem.* 35, No. 7. (1943).

Murphree, E. V., and others. Catalytic Cracking by the Improved Fluid Process. *Nat. Pet. News*, 37, No. 10. (1945).

Helmers, C. J., and others. Recent Developments in the Cycloversion Process. *Oil and Gas Journ.* 46, No. 32. (1947).

Burk, C. F. New Developments in Suspensoid Catalytic Cracking. *Oil and Gas Journ.* 45, No. 23. (1946).

Polymerization

Weinert, P. C., and Egloff, G. Catalytic Polymerization and Its Commercial Application. *Pet. Pro.* 3, No. 6. (1948).

Alkylation and Isomerization

Skinner, E. M. Experiences with Commercial Application of the Hydrogen Fluoride Alkylation Process. *Trans. Amer. Inst. Chem. Eng.* 41. (1945) 647.

Kenney, L. M. Problems in (H_2SO_4) Alkylation Plant Operation. *Pet. Ref.* 21, No. 7 (1942).

Evering, B. L., and others. The Commercial Isomerization of Lighter Paraffins. *Oil and Gas Journ.* 23, No. 25. (1944).

Polyforming and Hydroforming

Offutt, W. C., and others. Naphtha Polyforming. *Proc. Amer. Pet. Inst.* 26, Section III. (1946).

Offutt, W. C., and others. Utilization of Refinery Gases by the Polyform Process. *Pet. Ref.* 27, No. 10. (1948).

Hill, L. R., and others. Hydroforming. A Catalytic Method for Naphtha Upgrading. *Nat. Pet. News.* 38, No. 23. (1946).

Gasoline Treating

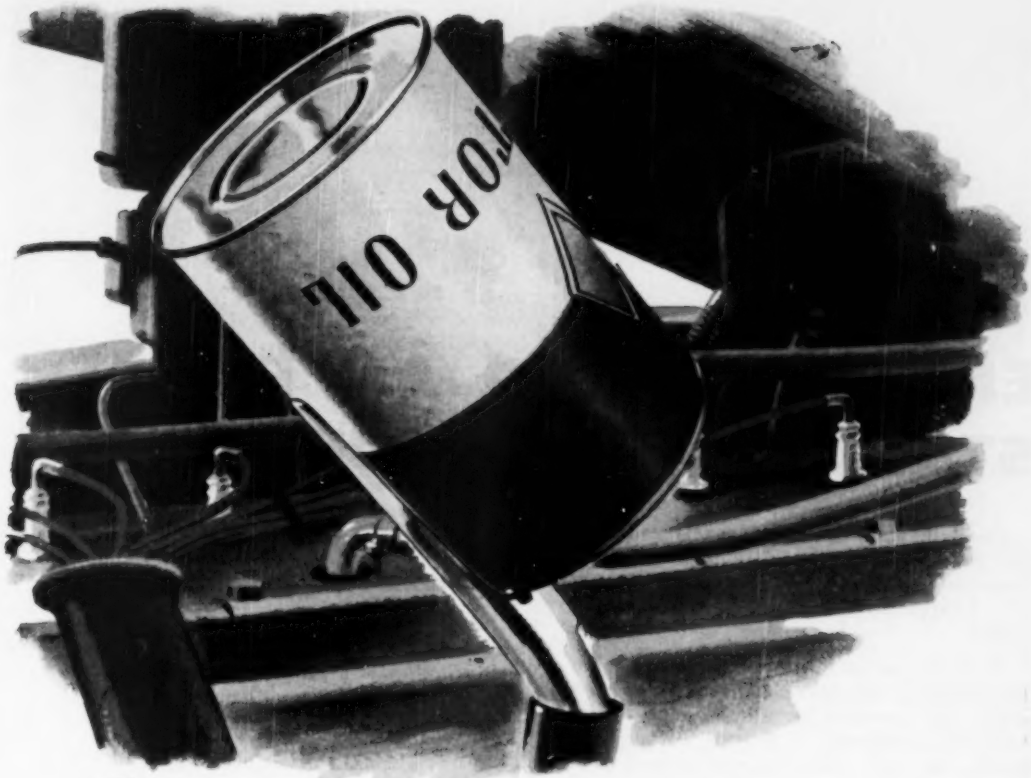
Brown, K. M., Mercaptan Extraction with Unisol Process. *World Pet.* 18, No. 7. (1947).

Happel, J., and Cauley, S. P. Tannins and Allied Chemicals in Mercaptan Removal Process. *Indus. and Eng. Chem.* 39, No. 12. (1947).

* * *

MOBILE PETROLEUM LABORATORY—

Personnel of two U. S. Army Reserve units at the Beacon, N. Y., laboratories of The Texas Company recently spent two weeks working in a Quartermaster mobile petroleum laboratory, interior of which is shown above. The units are underwritten by Texaco as part of the API Army affiliation program, in which oil companies sponsor reserve organizations so that necessary trained petroleum groups will be available for the Army in case of emergency. The air-transportable, air-conditioned laboratory—one of the five now in use by the Army—has complete equipment for testing fuels and lubricants in the field. These mobile petroleum laboratories are now touring Army depots and oil companies from coast to coast. Shown in the interior of the mobile lab are, left to right, Dewey McDonald, Douglas Phillips, and Paul Howe of Texaco's Beacon Laboratories.



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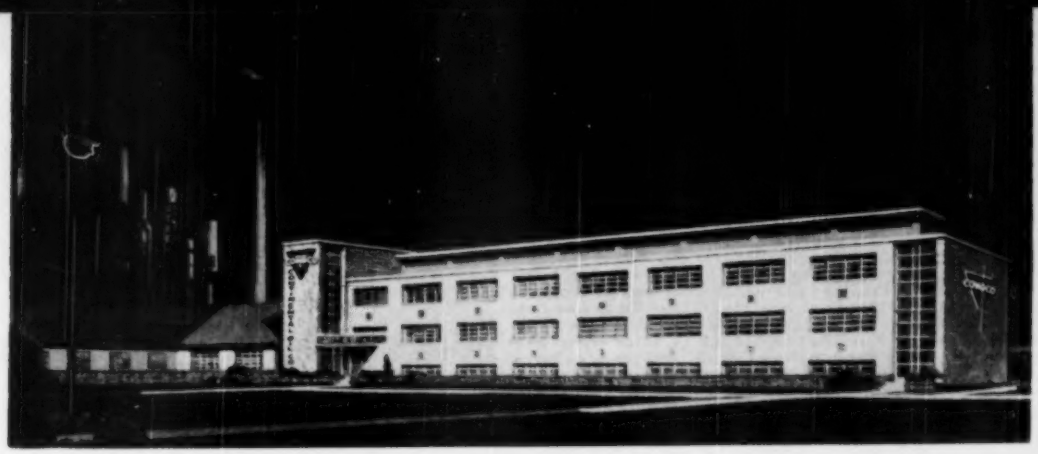


Refinery and Other Plant Construction

Petroleum Refiner's Next "Box Score" Tabulation Will Appear in the October Issue

Independents Plan Refinery, 1100-Mile Crude Pipe Line

A group of Texas and Arizona businessmen are backing plans for a 15,000 barrel per day refinery at Florence, Ariz., to be constructed in connection with a 1100 mile, 20-inch crude oil pipe line from Monahans, Texas (tapping the Permian basin) to Los Angeles. There is current market in Arizona for 25,000 to 35,000 barrels per day of petroleum products for which the proposed refinery will compete, according to a spokesman for the 50 independent operators who are backing the line. Head of the group of refinery backers is John Mills, Dallas.

Builder and owner of the $66 million line will be West Coast Pipeline Company, organized in January by the independent group. R. J. Bradley, Dallas, is president of the company and also heads San Juan Oil Company, Dallas. Bradley estimated it would be four to six months before the pipe line work is initiated. Capacity will be 200,000 barels a day. The independents were recently seeking government help in getting delivery on orders for about 200,000 tons of steel pipe and equipment.

Plans for North Dakota Refinery Are Announced

Plans are in the blueprint stage for a 2000-2500 barrel per day refinery at Grand Forks, N. Dak., for a company organized several months ago as Standard Oil Company of North Dakota, according to H. G. Letts, land man and public relations representative for the company. Standard Oil Company (Indiana) has filed suit in federal court over similarity in name, but as yet no hearing of the case has been held, according to Letts. Crude supply for the refinery will be from independent producers in Montana and Wyoming. The new company holds several drilling leases in the state, but does not have any actual wells, Letts said.

Officers of the new company are Thomas Mitchell Madden, Virginia, Minn., president; R. T. St. Clair, Northwood, N. Dak., vice president; and Keith V. Bacon N. Dak., secretary and treasurer.

Houston Plant to Make Ethyl Antiknock Compounds

A site on the ship canal near Houston has been selected by Ethyl Corporation for new manufacturing plants to produce more than 100 million pounds of chemical annually. The new plants will be integrated to manufacture all the tetraethyl lead, ethyl chloride, solium and chlorine, used in the processes for producing "Ethyl" antiknock compounds. Work on the project will begin immediately and will be completed, it is expected, by the end of 1951. Manufacturing facilities of the company, until this time, have been centered in Baton Rouge, La.

Auxiliary units will include a blender where tetraethyl lead is mixed with ethylene dibromide and ethylene dichloride to produce "Ethyl" antiknock compounds; laboratories; storage tanks for tetraethyl lead, chlorine, ethyl chloride, and ethylene dibromide; offices, employe change-houses, and showers. The installation will also include trackage for a fleet of tank cars for the delivery of antiknock compounds to oil company customers.

Cities Service Modernizes Ponca City, Okla., Refinery

An expansion and modernization program for its refinery at Ponca City, Okla., has been announced by Cities Service Oil Company (Delaware). From one to two years will be required to complete the program. New facilities will include a catalytic cracking unit of latest design, a catalytic polymerization unit, and a gas plant. Also included will be revision of the vacuum flashing unit, treating processes, installation of a new water cooling tower, increased storage capacity for finished products and additional steam, water and other facilities.

The present crude processing unit will be revamped to provide a 33 percent increase in capacity, to 20,000 barrels of crude oil daily. It will be operated in conjunction with the vacuum flashing

Above is architect's drawing of new research laboratory building which Continental Oil Company will build in Ponca City, Okla. Blending with the adjacent existing architectural pattern, the building is scheduled for completion in the fall of 1951.

CONTINENTAL Oil Company last month awarded contract for construction of a $2,250,000 central research laboratory building in Ponca City, Okla., which, besides housing research, "complement and coordinate existing laboratories of the company," President L. F. McCollum announced. Work is to start this month.

The new three-story structure comprising mainly six individual laboratory units, will be connected to Continental's newest office building in Ponca City and will contain almost 40,000 square feet of floor space, making a total of more than 85,000 square feet of laboratory space.

The building is to be of reinforced concrete construction, with exterior of stone and masonry. Wigton-Abbott Corporation, engineers and contractors, Plainfield, N. J., has the contract.

Continental's central research laboratories will occupy approximately half of the laboratory space in the new building. The central research laboratories will consist of an organic chemical laboratory, comprised of a petroleum chemical division and a lubricating oil division; an analytical laboratory, consisting of both chemical and physical method units; a physics research laboratory, including such equipment as electron microscope, X-ray defraction unit and mass spectrometer; and a colloid laboratory.

Approximately the remaining half of the new building will be occupied by the laboratory section of the production research division.

Continental's development and research department is under the general supervision of H. G. Osborn, vice president. Department manager is L. L. Davis.

unit, which will use residuum as feed stock and produce gas oil feed for the cat cracker and a product used in blending heavy fuels.

The catalytic cracking unit will be the fluid type and will replace the present thermal cracking units. The new unit will increase to five the total number of fluid cat crackers operated at Cities Service refineries. The Lake Charles, La., refinery has three such units, and a recently completed modernization program at the East Chicago, Ind., plant included another.

Design for the expansion and modernization program was by The M. W. Kellogg Company, New York.

Sweco Building New Mexico Package-Type TCC Unit

New Mexico Asphalt and Refining Company has completed contract negotiations with Southwestern Engineering Company (Sweco), Los Angeles, for a 6000-barrel-per-day package-type TCC plant and 300-barrel-per-day cat poly unit at the Artesia, N. M., refinery. The TCC unit is licensed by Socony-Vacuum Oil Company, Inc., and the cat poly plant by Hydrocarbon Research. It is expected that the plant will be completed between February and May, 1951.

The proposed refinery operation will split the crude charge to the topping and TCC feed preparation section. The topped crude from the topping section will also charge to the TCC feed preparation section. Straight-run gasoline will charge to the desulfurization unit. Overhead from the TCC feed preparation section will charge to the TCC catalytic section, with bottoms from the TCC feed preparation section and the TCC cycle oils charging to the thermal cracking unit. Gas from the thermal cracking unit and TCC gas recovery section will charge to the poly plant. Products of the proposed operations are 92.6 F-1 octane premium gasoline, 86.0 F-1 octane house-brand gasoline, 49.8 cetane diesel oil, 250 SFS at 122° F. heavy fuel oil, and fuel gas.

Present operations of the Artesia refinery include crude topping, desulfurization, and thermal cracking, charging New Mexico and West Texas crudes.

Du Pont Completing Units For Tetraethyl Manufacture

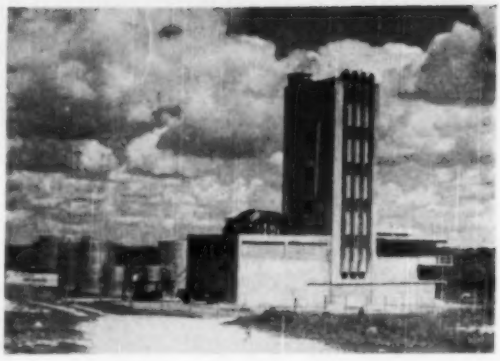
Division of the Du Pont Company has announced that expanded facilities for manufacturing its tetraethyl lead antiknock compounds for gasoline will be in production before January 1. The new manufacturing units, now approaching completion at the company's Chambers Works, Deepwater Point, N. J., will raise its capacity for making tetraethyl lead by one third.

The expansion program was considerably accelerated because of the Korean war.

U. S. Independent Offers To Build Venezuelan Plant

Edwin W. Pauley, independent oil operator of California, has made a proposal to two oil companies in Venezuela to finance and build a $4 million plant to process natural gas now wasted and to stabilize crude oil. Site planned is for the El Roble oil field in eastern Venezuela. Pantepec Oil Company, C.A., has accepted the terms of Pauley's offer, and Creole Petroleum Corporation, a Standard Oil Company (New Jersey) subsidiary, has it under study.

These producing companies would have their natural gas, now being flared, and crude oil processed in the plant. Pauley's group would receive a share of the increased value of the output of the oil field. Crude produced in this oil field is of a type that evaporates easily, and part of the output plant's job would be to cut down loss of oil from this process. At present, Pantepec is producing daily about 3200 barrels of oil in the field, and Creole about 2200 barrels.



NEW PLANT — The successful completion and start up of a $600,000 plant to make absolute alcohol from molasses in Ciudad Trujillo, Dominican Republic has been announced by Dr. Robert S. Aries, President of R. S. Aries & Associates, New York consulting engineering firm. The new plant, the Destileria Universal, has a rated production of 7200 gallons per day, or about 2.5 million gallons per year, of absolute (100 percent) ethyl alcohol. Designed to withstand earthquakes and winds with a velocity of 180 miles per hour, the plant is completely instrumented for automatic operation and uses benzene for the dehydration of the alcohol. The output of the plant will be used for blending with gasoline, of which about 15 million gallons are consumed annually in the Republic.

Bureau Coal-Oil Plant Is Nearing Completion

Completion of the major construction contract held by Koppers Company, Inc., on the Bureau of Mines gas-synthesis demonstration plant at Louisiana, Mo., an 80-to-100-barrel-a-day unit that will convert coal to oil by a modified Fischer-Tropsch process, has been announced by Secretary of the Interior Oscar L. Chapman. The $4.9 million contract was for design and construction.

Before the plant begins integrated operations early next year, work remains on the piping insulation and road subcontracts. Large quantities of synthesis catalyst must be prepared and reduced on the site before initial operation, and tests and partial runs will have to be made to prove the operability of the various units.

ECA Considers Cat Cracking Expansion in West Germany

The Economic Co-operation Administration has under consideration proposals to expand catalytic cracking facilities at West German refineries to about 3.5 million tons per year (70-75,000 barrels daily). Government officials said Germany now has practically no cracking capacity but has more than enough topping facilities.

There are three separate projects under consideration, one of which would convert a topping plant in Bremen to cracking operations.

Construction Slated For Kentucky Petrochem Plant

The construction and engineering contract for the new petrochemical plant of Mathieson Hydrocarbon Chemical Corporation, near Brandenburg, Ky., has been awarded to E. B. Badger & Sons Company, Boston, with Stone & Webster Engineering Corporation collaborating on other phases. Work will begin either late this summer or early this fall, according to S. Cottrell, operations manager. Final construction will require one year but it is expected that some units of the $17 million plant will be in operation by the spring of 1951.

Principal product to be made from ethane by cracking and chlorination will be ethylene glycol.

New Bureau Lab to Use Isotopes in Oil Research

A new radiochemical laboratory where isotopes will be used in petroleum research is expected to be completed in September at the Bureau of Mines petroleum experiment station, Bartlesville, Okla. The tracers will be used in various investigations in the secondary recovery of petroleum by water flooding and the injection of gas and air. The first application of both radioactive and stable tracers will be in waters used for subsurface injection water-flooding.

Ground for the estimated $35,000 structures was broken in June. The building will include a small "hot" laboratory for storing and handling the radioistopes as received, an adjoining intermediate lab where the isotopes will be diluted and separated, and a large laboratory for actual tracer work. There also will be a room where radioactivity can be detected and measured, and a dark room for developing "film badges."

Stanolind Ups Gaso Plant

Stanolind Oil & Gas Company is planning to double the size of its 100,000-mcf.-a-day gasoline plant, seven miles west of the Ulysses, Kan., synthetic plant.

The synthetic gasoline-from-natural gas plant which Stanolind has planned to build near Garden City, Kan., has been abandoned officially by the company in favor of selling all of its Hugoton Field gas for pipe line purposes.

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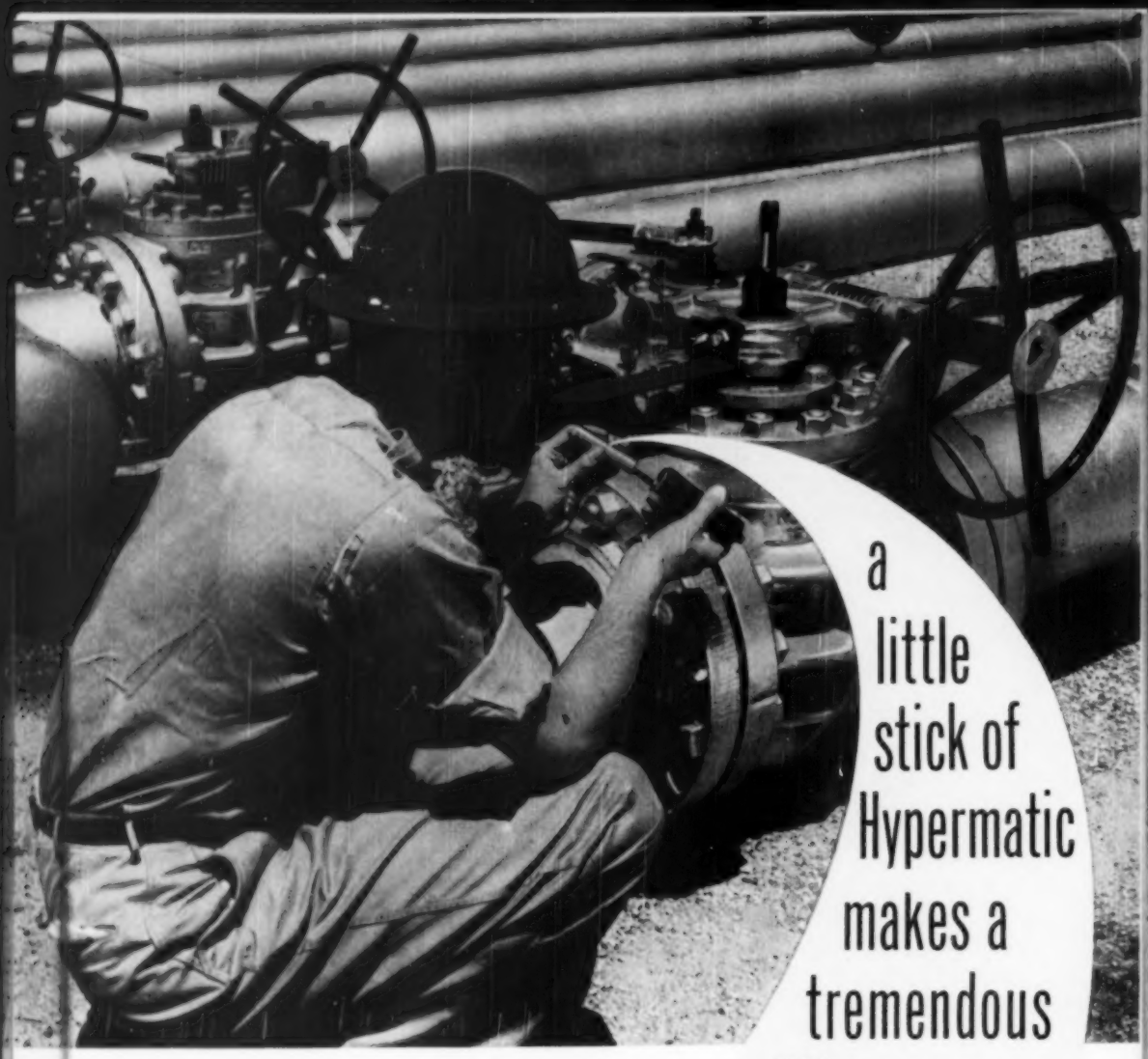

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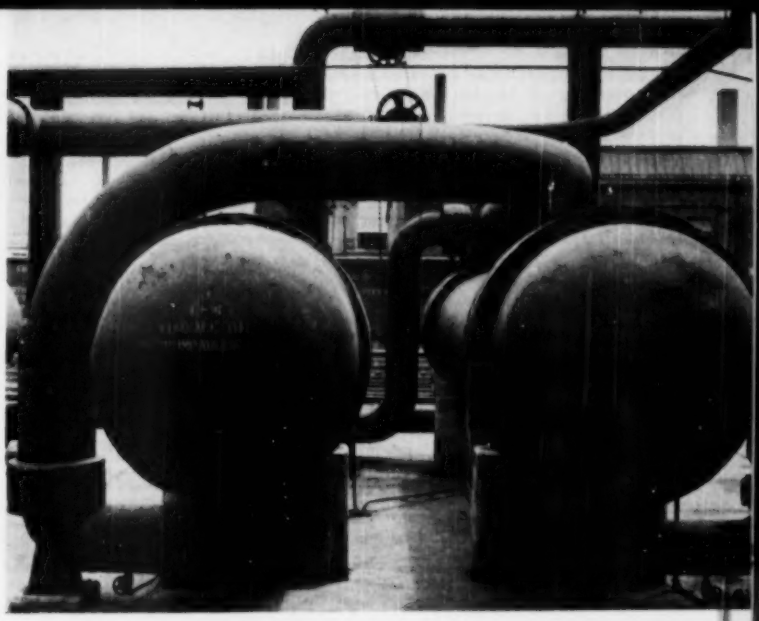


Figure 1. Refinery Heat Exchangers for Furnace Oil Heating. Preliminary selection of units such as these is aided by the methods outlined in this article.—Photo courtesy Standard Oil Company (New Jersey.)

Planning Refinery Heat Transfer Equipment

PART I: Basic Relations

TYLER G. HICKS, Hicks Associates, New York

PRIOR TO THE outbreak of the World War II most refinery heat transfer equipment was designed by firms specializing in its manufacture. After the start of the war, heavy demands from government agencies slowed manufacturers' design work considerably. Simultaneous rapid expansion of refining, natural gasoline, and petro-chemical installations placed a further burden on manufacturers' design departments. Delays and long-term delivery of equipment resulted.

To speed plant layout many refiners made preliminary design and cost calculations for heat transfer equipment. The calculations were not intended to replace those which would ultimately be made by the manufacturer. Instead, the results were used as a yardstick in answering the constantly recurring question of "how big, how long, and how much does it cost?" So many refiners obtained satisfactory designs with these preliminary calculations that the practice has spread throughout the field. Since a simple, complete statement and solution of the general design problem is not readily available in one source, it is believed that a presentation of all needed equations and constants, together with illustrations of their uses, will be of value to refiners.

PREHEATERS, exchanger type steam generators, precoolers, condensers, condensate still exchangers, jacket water coolers, and reboilers are a few of the heat transfer devices to which preliminary design calculations are often applied. The hot fluid may be a liquid or a gas, according to the refinery application. Likewise, the cold fluid may be in the liquid or gaseous state. Uniform hot and cold fluid temperatures or continuously changing temperatures in both fluids can be analyzed by specific calculation procedures.

The usual practice among refinery designers has been avoidance of specialized equations for each type of heat exchanger. Generalized equations which can be applied to any type of exchanger in which the heat transfer process follows certain simple rules have been preferred. Such an approach saves time and effort because heat transfer calculations can become involved and time-consuming when specialized equations suitable for only one type of unit are derived. The equations to be presented in this article are the generalized type, permitting direct solution for any unknown, provided that the path and temperature variation of each fluid are known. The latter conditions are always known when the exchanger has a specific application.

Fluid Conditions

Heat can be transferred from one fluid to another in refinery equipment in a number of ways. To simplify analysis, the various means used will be separated into five cases.

Case I: Hot fluid at constant temperature. With the hot fluid at constant temperature, the cold fluid temperature rises during passage through the apparatus. Figure 2-I shows the relation between temperatures and area. As can be seen by a study of the figure, the cold fluid temperature increases with length of surface and will finally approach the hot fluid temperature if the length is sufficient. However, as is well known, there is an economic limit to the length of heat transfer surface. This is one of the problems which continually face the refiner designer; how long can this surface be made without running into exorbitant initial, operating, and maintenance costs?

Case II: Cold fluid at constant temperature. With the cold fluid at constant temperature (not necessarily a

low temperature), the hot fluid temperature decreases as area or length of heat transfer surface is increased. Figure 2-II shows the temperature and area relations. An example of Case II is the cooling of fluid catalytic cracker flue gases in an exchanger type steam generator. The boiling water at a constant "low" temperature cools the hot flue gases before they are passed through the electrical precipitator.

Case III: Parallel fluid flow. In parallel flow the hot and cold fluid move in the same direction on opposite sides of a tube or plate. The greater the distance travelled by the two fluids, the nearer the approach of their temperatures. As shown in Figure 2-III, the hot fluid temperature decreases as it surrenders heat to the cold fluid. The heat thus obtained raises the temperature of the cold fluid. Parallel type heat exchangers receive their name from the flow conditions existing in them.

Case IV: Counter flow of fluids. Opposite paths of flow for the hot and cold fluids produces counter flow heat transmission, Figure 2-IV. As flow progresses the exit temperature of the cold fluid approaches the entrance temperature of the hot fluid and the exit temperature of the hot fluid approaches the entrance temperature of the cold fluid. Three relations between temperature curves can exist; they may be parallel, divergent, or convergent. Orientation of the curves is determined by the capacity of each fluid to absorb or surrender heat.

Case V: Fluids at constant temperature. Either flow of the fluids or heat supply to the hot fluid is such that both fluids remain at constant temperature, Figure 2-V. Heat transmission under these conditions is usually characterized by condensation of one fluid at constant temperature and evaporation of another at a constant temperature in refinery apparatus.

Mean Temperature Difference

Study of Figure 2 shows that the change in temperature of either fluid is not linearly a function of area or length. During heat transmission the fluid temperatures converge, the rate of convergence depending upon temperature difference. When the temperature difference is large, the rate of convergence is rapid. As the temperature difference decreases the rate of convergence also decreases. Hence, since the rates of convergence are different at every point along the path of flow, the mean temperature difference between inlet and outlet is not an arithmetic mean.

Exact determination of the mean temperature difference is necessary because the quantity of heat transferred from the hot fluid to the cold one is a function of: 1) mean temperature difference, 2) heat transfer surface area, and 3) over-all coefficient of heat transmission. Derivations show that the mean temperature difference when the temperature of either, or both, fluids changes and the mean specific heats and over-all coefficient of heat transmission remain constant, is

$$t_m = \frac{\Theta_A - \Theta_B}{\ln(\Theta_A/\Theta_B)} \qquad (1)$$

where t_m = logarithmic mean temperature difference

Θ_A = temperature of entering hot fluid — temperature of surrounding cold fluid, °F.

Θ_B = temperature of leaving hot fluid — temperature of surrounding cold fluid, °F.

ln = logarithm to the base e = 2.71828.

This is known as the logarithmic mean temperature difference.

Occasionally there are instances in the design of refinery heat transfer apparatus where the arithmetic mean temperature difference can be used. Since an arithmetic mean is easier and quicker to determine, there is a tendency to use it when in a hurry. From the standpoint of accuracy, use of the arithmetic mean should be discouraged, even though the difference between it and the log may be slight. Consistent use of the log mean temperature difference will assure accurate results in all refinery heat transmission calculations.

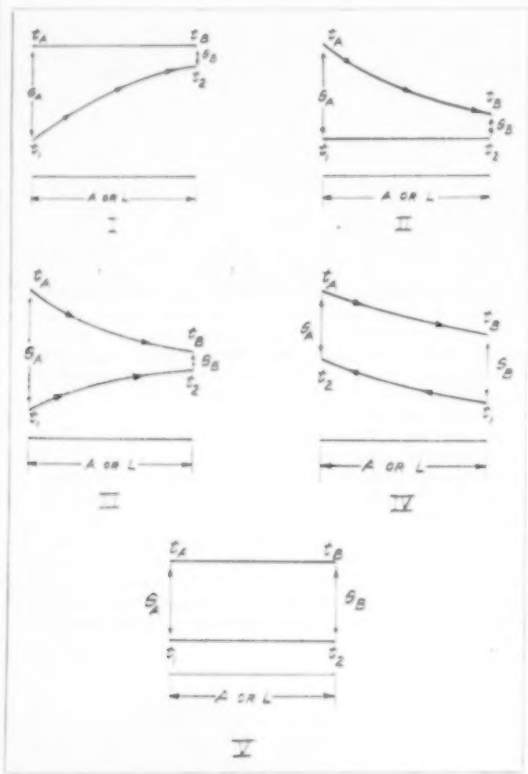


Figure 2. Diagrams showing the five general cases of heat transfer in engineering apparatus. From rough plots such as these, the various temperatures which must be considered in preliminary design are obtained.

Exchanger Heat Transfer

Once a heat exchanger has been brought up to its normal operating temperature by establishing flow of the hot and cold fluids, it is known as a steadily operated exchanger. For any steadily operated exchanger,

$$q = UAt_m \qquad (2)$$

where q = heat transferred, Btu/hr

U = over-all coefficient of heat transfer, Btu/hr/sq ft/°F.

A = area of heat transfer surface, sq ft.

This equation is based on the laws of heat transmission and is valid for all five cases discussed above when *U* and

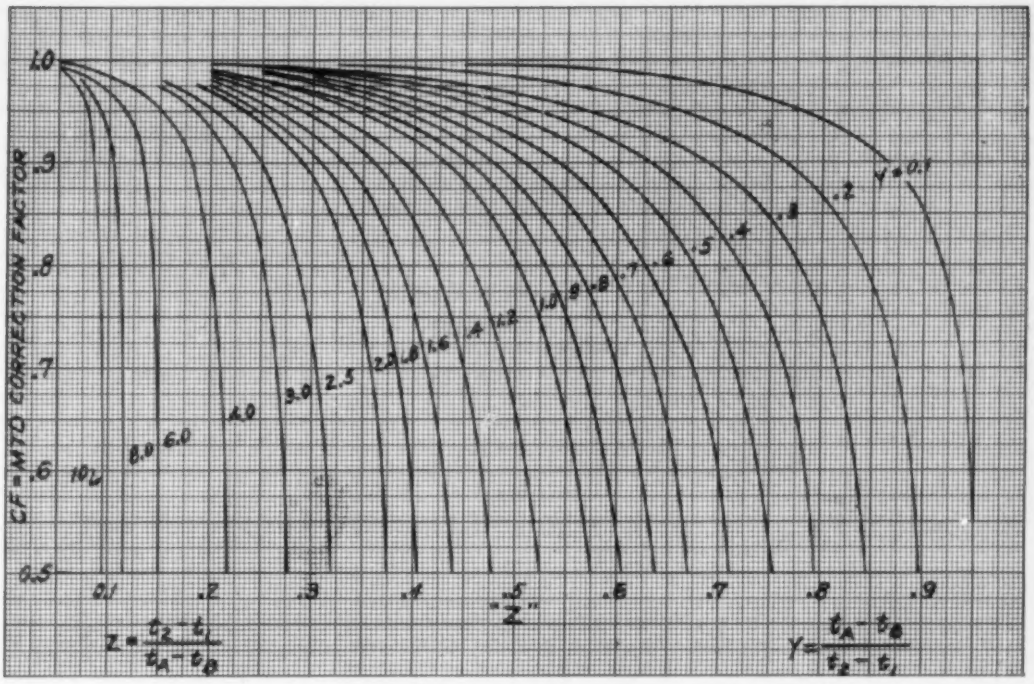


Figure 3. Mean Temperature Difference Correction Factors for Other than Counter-Flow Conditions in Process Heat Exchangers. Use of these factors is explained in the text of this article.

the specific heats of the fluids are constant.

Using the law of conservation of energy and neglecting heat losses to the surrounding atmosphere,

$$q = w_h c_h (t_A - t_B) = w_c c_c (t_2 - t_1) \quad (3)$$

where w_h = hot fluid flow rate, pounds per hour

w_c = cold fluid flow rate, pounds per hour

c_h = specific heat of hot fluid

c_c = specific heat of cold fluid.

Equation 3 states that the amount of heat surrendered by the hot body equals that gained by the cold body when external heat losses are negligible. Since external heat losses in refinery exchangers are often small, Equation 3 has many uses.

The over-all coefficient of heat transfer, U, is not always a constant for refinery equipment. For instance, in a steam heated oil heater, U may vary from 30 at 30° F. to 100 at 220° F. Under these conditions Equation 2 cannot be used to determine q because it is based on a constant value of U. Instead, the more general equation,

$$q = A\left[\frac{U_1(t_A - t_2) - U_2(t_A - t_1)}{\ln \frac{U_1(t_A - t_2)}{U_2(t_A - t_1)}}\right] \quad (4)$$

U_1, U_2 = linear values of the over-all coefficient of heat transfer, U; (Other symbols as before) must be used for parallel or counterflow operation.

Application of this equation involves a study of U to determine if it is linear in temperature. If so, the heater is assumed to consist of a number of heaters in series and the equation solved separately for each linear portion.

When parallel flow and counterflow are combined in a single exchanger, the resulting flow is called reversed. Many refinery heat exchangers utilize reverse flow because it permits ready adjustment of fluid velocities to economic values. Computation of heat transfer rates in reversed flow heaters cannot be made directly by means of Equation 2 because the mean temperature difference must be corrected for the deviation from pure parallel flow and counterflow. Figure 3 is a plot of correction factors for single pass shell and multi-pass tube heat exchangers. The logarithmic mean temperature difference is multiplied by the correction factor before insertion in Equation 2.

At several points in the discussion

TABLE 1

Over-All Coefficients of Heat Transfer, U—Btu./hr./sq. ft./°F.

Type of Heat Exchanger	State of Controlling Resistance: Free Convection, U	State of Controlling Resistance: Forced Convection, U	Typical Fluid	Typical Apparatus
Liquid to liquid	25—60	150—300	Water	Liquid-to-liquid heat exchangers
Liquid to liquid	5—10	20—50	Oil	
Liquid to gas	1—3	2—10		Hot-water radiators
Liquid to boiling liquid	20—60	50—150	Water	Brine coolers
Liquid to boiling liquid	5—20	25—60	Oil	
Gas to liquid	1—3	2—10		Air coolers, economizers
Gas to gas	0.6—2	2—6		Steam superheaters
Gas to boiling liquid	1—3	2—10		Steam boilers
Condensing vapor to liquid	50—200	150—800	Steam to water	Liquid heaters and condensers
Condensing vapor to liquid	10—30	20—60	Steam to Oil	
Condensing vapor to liquid	40—80	60—150	Organic vapor to water	
Condensing vapor to liquid		15—300	Steam-gas mixture	
Condensing vapor to gas	1—2	2—10		Steam pipes in air, air heaters
Condensing vapor to boiling liquid	40—100	.....		Scale-forming evaporators
Condensing vapor to boiling liquid	300—800	.....	Steam to water	
Condensing vapor to boiling liquid	50—150	.....	Steam to Oil	

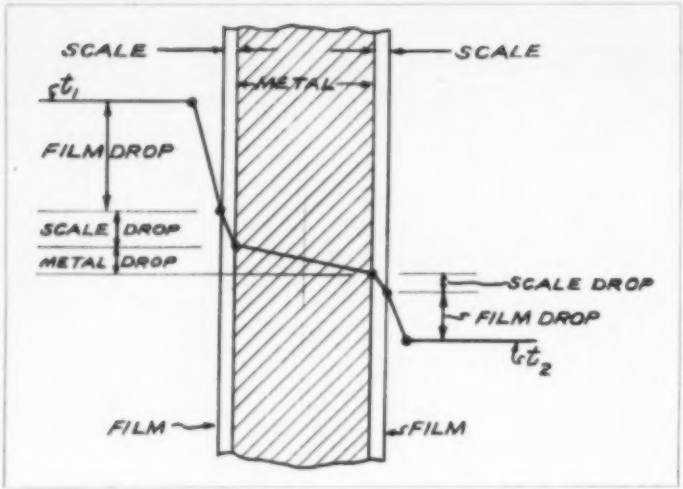


Figure 4. Typical Temperature Drops During Heat Transfer through Scaled Metal. As can be seen, the surface films cause the greatest temperature drop. For this reason, accurate determination of film coefficients is important.

thus far, the importance of the over-all coefficient of heat transfer, U, has been mentioned. For any given heat exchanger the numerical value of U is a function of several factors, a few being the degree of scale accumulation on heat transfer surfaces, the nature of the hot and cold fluids, and the fluid velocity over the equipment surface. Determination of the correct value of U for various operating conditions has been the subject of many investigations throughout the world. For preliminary design calculations the value of U can usually be safely be assumed to be somewhere in the range listed in Table 1. Statement of the exact value of U for any heat exchanger application in refineries cannot be made because the variation is so great.

Free convection values of U are for conditions where there is no positive circulation of the fluid by mechanical means. Forced convection results when an external force propels the fluid past the surface to be heated or cooled. The majority of heat exchangers in refining, natural gasoline, and petrochemical plants are of the forced convection type because a pump, blower, or fan is used to move the fluid past the heating or cooling surface.

More accurate values of U can be found from the relation

$$U_o = \frac{1}{\frac{r_2}{r_2 f_i} + \left(\frac{r_2}{k}\right) \ln(r_2/r_1) + (1/f_o)} \quad \text{for tubes} \qquad (5)$$

and

$$\frac{1}{U_o} = \frac{1}{f_i A_i} + \frac{L}{k_A} + \frac{1}{f_o A_o} + \frac{1}{f_o A_m} \quad \text{for flat plates} \qquad (5a)$$

where U_o = over-all coefficient of heat transfer based on the outer area of the tube
r_1 = inner radius of tube, inches
r_2 = outer radius of tube, inches
k = specific thermal conductivity, Btu/hr per °F per sq ft per inch
f_i = inner film coefficient, Btu/hr/°F/sq ft of inner tube surface
f_o = outer film coefficient, Btu/

Figure 5. Plot of Over-All Coefficient of Heat Transfer Versus Temperature to Determine which Ranges Are Linear, or Nearly So. The values are then used as shown in illustrative problem No. 1 in the text.

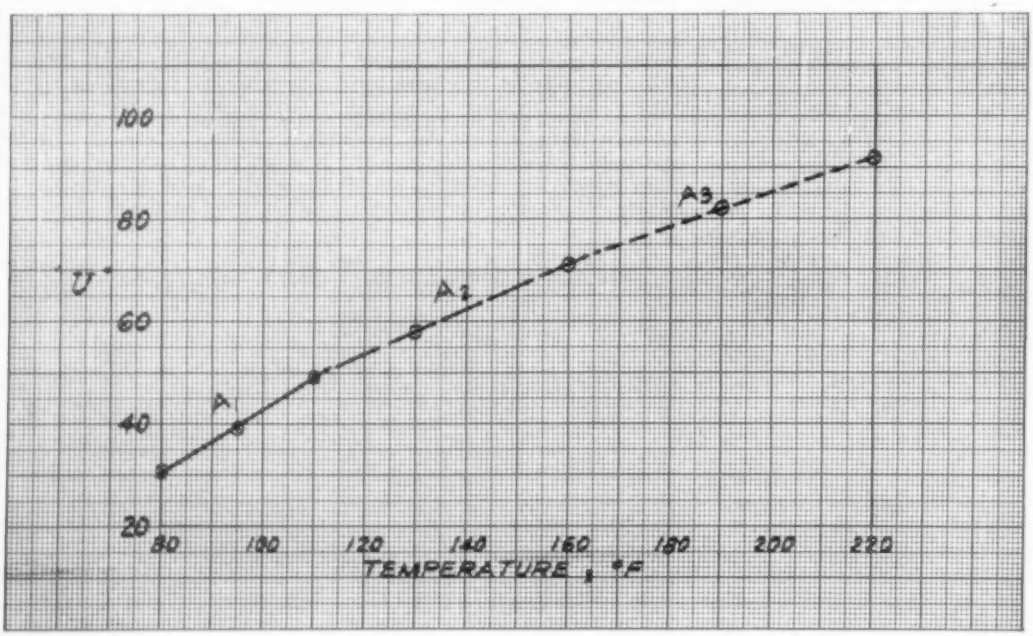


TABLE 2

Film Coefficients for Scale Deposits Btu./hr./sq. ft./°F.

Liquid gasoline	2000
Refined petroleum fractions (liquid), oil-bearing steam	1000
Distillate bottoms (above 25° API), gas oil or liquid naphtha below 500° F., scrubbing oil	500
Gas oil above 500° F.	330
Liquid naphtha above 500° F., quenching oils	250
Topped crude below 25° API, fuel oil	200
Cracked residuum	100

TABLE 3

Thermal Conductivities of Metals
k = Btu./hr./sq. ft./°F./ft.

Substance	°F.	k
Metals:		
Antimony	32	10.6
Antimony	212	9.7
Bismuth	64	4.7
Bismuth	212	3.9
Cadmium	64	53.7
Cadmium	212	52.2
Gold	64	169.0
Gold	212	170.0
Iron, pure	64	39.0
Iron, pure	212	36.6
Iron, wrought	64	34.9
Iron, wrought	212	34.6
Iron, cast	129	27.6
Iron, cast	216	26.8
Steel (1 percent C)	64	26.2
Steel (1 percent C)	212	25.9
Magnesium	32–212	92.0
Nickel alloy (62Ni, 12Cr, 26Fe)	68	7.8
Platinum	64	40.2
Platinum	212	41.9
Alloys:		
Admiralty metal	86	65
Brass	100	65
Bronze, commercial		109
Constantan (60Cu, 40Ni)	64	13.1
Constantan (60Cu, 40Ni)	212	15.5
Nickel silver	32	16.9
Nickel silver	212	21.5
Platinoid	64	14.5

hr/°F/sq ft of outer tube surface

f_i = inner film coefficient, Btu/hr/°F/sq ft of inner plate surface

f_s = film coefficient for scale deposit, Btu/hr/°F/sq ft

f_o = outer film coefficient, Btu/hr/°F/sq ft of outer plate surface

L = thickness of plate, inches

The value of U obtained from this equation is more accurate than the generalized values given in Table 1 because the film coefficients f_i, f_s, and f_o are readily found.

During heat transfer through a tube wall or flat plate the surface films offer the greatest resistance, as shown by the temperature drops in Figure 4. Film coefficient values, upon which the temperature drop depends, are a function of thermal conductivity, specific heat, density, and viscosity. These, in turn, are a function of the temperature level. With a given fluid and velocity, the film coefficient is dependent on the direction of flow relative to the heat transfer surface. Equations for determining the value of film coefficients for various refining applications of heat exchangers are given in most engineering handbooks. Film coefficients for scale deposits in refining, natural gasoline, and petrochemical exchangers are listed in Table 2.

Illustrative Examples

Example 1: Determine the area required in a refinery exchanger used to heat a hydrocarbon oil from 80° F. to 220° F. if 10,000 lb./hr. of oil with a specific heat of 0.50 flow through the heater. The over-all coefficient of heat transfer varies as follows:

t, °F	80	95	110	130	160	190	220
U	30.5	39	49	58	71	82	92

The oil flows through straight tubes and steam condensing at 230° F. is used for heating.

Solution: Inspection of the values of U shows that they are not linear throughout. Hence, Equation 4 must be used. Values of U between 80 and 110° F., 110 and 160° F., and 160 and 220° F., appear to be linear. A plot as in Figure 5 shows that they are, approximately. Equation 4 is then applied to each plot, as follows.

80 to 110° F.:

$$A_1 = \frac{10{,}000(0.50)\,(110-80)\ln[(30.5)\,(230-110)/49(230-80)]}{30.5(230-110)-49(230-80)}$$

$A_1 = 29.9$ sq. ft.

110 to 160° F.:

$$A_2 = \frac{10{,}000(0.50)\,(160-110)\ln[(49)\,(230-160)/71(230-110)]}{49(230-160-71(230-110)}$$

$A_2 = 45$ sq. ft.

160 to 220° F.:

$$A_3 = \frac{10{,}000(0.50)\,(220-160)\ln[(71)\,(230-220)/92(230-160)]}{71(230-220)-92(230-160)}$$

$A_3 = 116$ sq. ft.

The total required area is the sum of the individual areas, or about 191 sq. ft. A heater with a total area of 200 sq. ft. would probably be selected for this refinery application. As can be seen, the manufacturer's recommendation would be somewhere in the 190 to 220 sq. ft. range. Hence, the over-all dimensions of the heater selected would approximate, rather closely, the actual dimensions.

Example 2: What is the over-all coefficient of heat transmission for a 1-inch outside diameter refinery condenser tube which has a steam side film coefficient of 2000 and a water side film coefficient of 670? The tube is 70:30 brass, 0.049 inch thick, and has a thermal conductivity, k, of $65(12) = 780$, Table 3.

Solution: Equation 5a applies.

$$U_o = 1 \div \left(\frac{1.108}{670} + \frac{0.5}{780}\ln(1.108) + \frac{1}{2000}\right)$$

$U_o = 450$ Btu/hr/°F/sq ft

$$U_i = \frac{r_1}{r_2}\,U_o = 1.108 \times 450 = 500 \text{ Btu/hr/°F/sq ft}$$

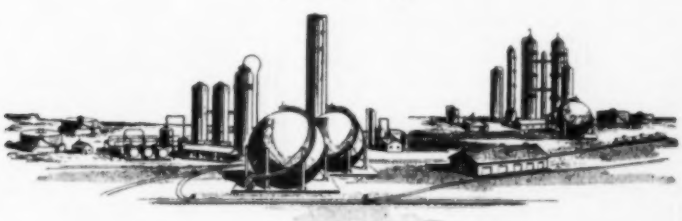
where U_i = over-all coefficient of heat transfer based on the inner area of the tube

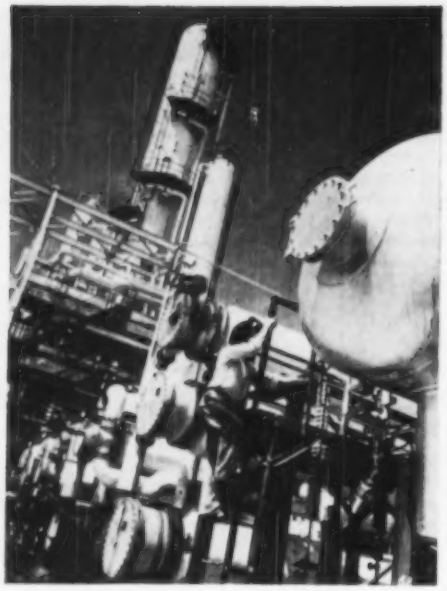
Comparing this value with those given in Table 1, it is seen that the range for "condensing vapor to liquid, steam to water" is 150 to 800. The computed value falls within the given range.

This discussion provides the introduction to calculations of heat transfer in refinery equipment. Future articles will discuss the efficiency of refinery heat transfer apparatus and methods for determining the most economical dimensions of heaters.

(End of Part I. Part II will appear in an early issue.)

* * *





Left, above—Checking Heat Exchangers at Topping Unit, Caltex Refinery located near Bordeaux, France. Right, above—Sampling at Treating Unit of Rebuilt Refinery.

Caltex Refinery Near Bordeaux Goes Into Full Production

THE Caltex refinery near Bordeaux, France, has reached capacity processing of 14,000 barrels daily, thus climaxing a two-year reconstruction costing more than $8 million, Chairman W. H. Pinckard of the California Texas Oil Company has announced.

The 16-acre plant is owned by Raffineries de Petrole de la Gironde, in which Caltex has an interest. It is situated near Bec d'Ambes at the junction where the Garonne and Dordogne Rivers flow into the Gironde 15 miles north of Bordeaux. It will process Arabian crude into gasoline, kerosine, diesel gasoil, as well as light and heavy residual oils for fuel.

Virtually destroyed during the war, the Gironde refinery was rebuilt as part of France's so-called Monnet plan, which called for country-wide industrial rehabilitation, and provided for restoration of four large capacity refineries at strategic French points.

Present plans call for a yearly production of 600,000 tons of petroleum and products—more than double the plant's prewar output. Aside from rehabilitating 410,000 barrels tankage already on the site, an additional 960,000 barrels of tank capacity have been built.

Originally built in 1932, with an 8000-barrel daily capacity, it was first bombed in 1940. Subsequently it was destroyed.

Because refineries that suffered partial rather than complete damage were permitted to rebuild first, authorization for the Gironde plant did not come through until 1947. Building started early in 1948 has now been completed.

The Gironde refinery was built without any ERP funds, Pinckard said. About 60 percent of the materials was obtained in France itself. Arthur G. McKee & Company designed the process installations, while local engineering groups worked on rehabilitating existing installations besides tankage, utilities, etc.

Forty thousand tons of sand were needed to level off the site which had originally been built from alluvial fill. The power plant, relatively undamaged by the bombing, was reconditioned to provide steam generating capacity of 115,000 pounds an hour. Electric generators with a 1300-kw. capacity service the unit while an 11,000-gpm. pumphouse supplies cooling water from the Dordogne River.

Pier facilities have been expanded. Tankers can move upriver from the sea 50 miles away and tie up at the plant site.

Overland freight movement is served by loading ramps accommodating 50 tank cars and 40 trucks.

The plant first went into operation in mid-February, but by the time the formal opening on May 15, there was already a question as to whether it would be able to supply all the needs. Two million tons of production yearly would seem closer to the needs of the Southwest according to the technical counselor for the Ministry of Commerce and Industry, M. Taix.

The Gironde refinery is the second of the Caltex group to go into postwar operation in Europe, earlier this year, a new Caltex refinery having been completed at Rotterdam at a cost of close to $24 million with a 20,000-barrel-daily capacity. It will serve Holland, Belgium, Luxembourg, and Switzerland.

The crude distillation unit is designed

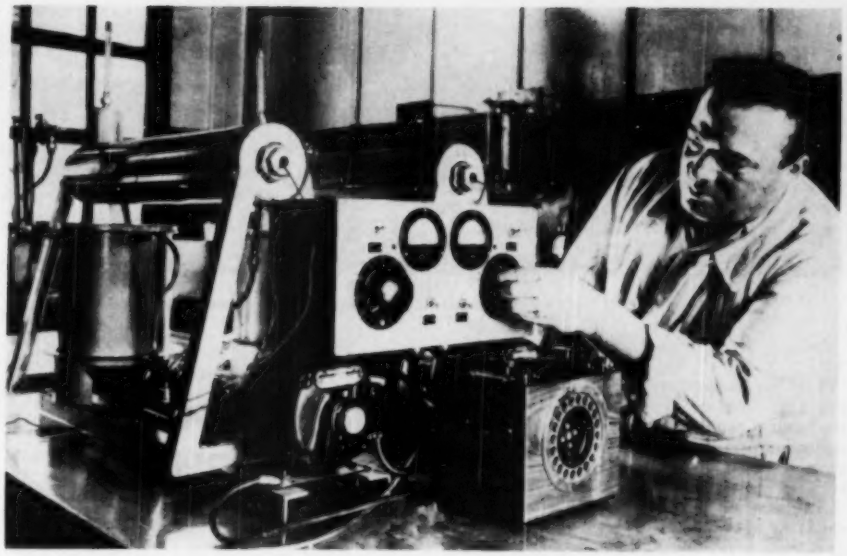


Photo at right shows operator setting the NBTL heater for testing navy special fuel oil, Gironde refinery.

Bottom-of-page photos: Left—At Barge Dock, Dordogne River. The Gironde plant is at the junction of two rivers.

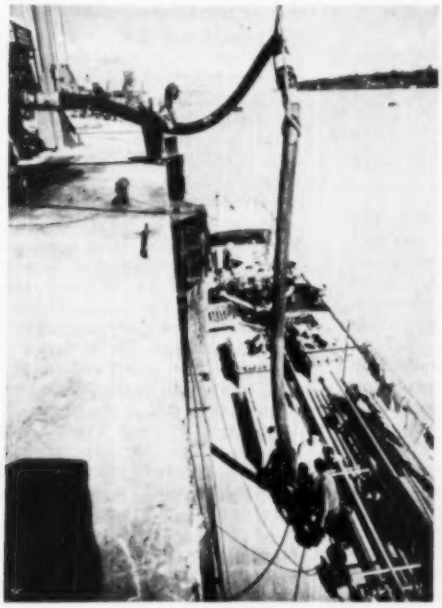
Right—At the Truck Loading Rack. Some of Storage shows in the background.

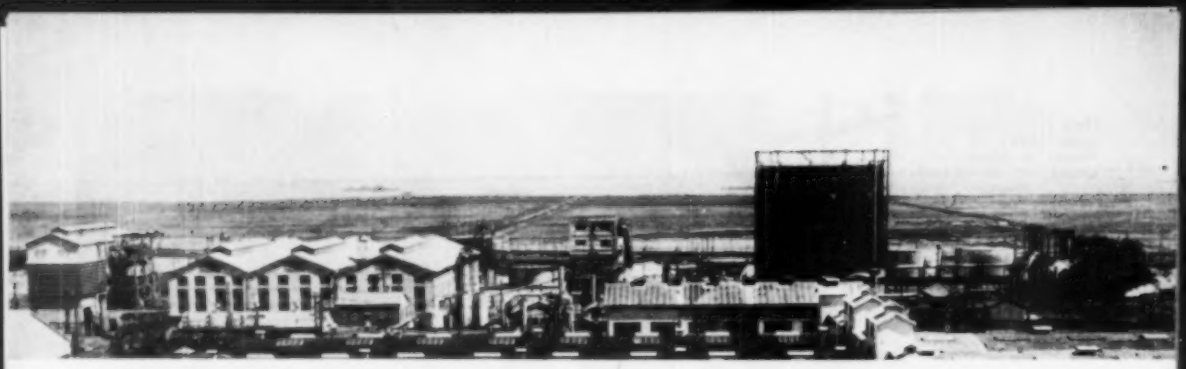
for a crude thruput of 14,000 barrels per stream day which allows charging 12,400 barrels of crude on a calendar day basis. The atmospheric column separates crude into one whole gasoline cut, one kerosine distillate cut, two gasoil cuts, and residuum. Minimum residuum yield is 35 percent of crude.

The crude distillation unit has naphtha re-run facilities to separate whole gasoline into a light naphtha cut for sweetening and blending into finished gasoline. Naphtha bottoms are charged to the naphtha reformer unit. A stabilizer debutanizes (or depropanizes, depending on finished gasoline vapor demands) light straight-run naphtha.

The thermal reformer with a UOP process can charge 3200 barrels per stream day of heavy naphtha and has towers for vapor phase clay treatment of reformed naphtha. A reconditioned stabilizer controls vapor pressure of the naphtha reformate. The unit's design permits flexibility in reforming severity to permit variation of the product octane number for a reasonably wide range. Gas produced by the unit goes into the refinery fuel system.

A 3650 barrels-per-stream-day lead sulphide gasoline treating plant sweetens light naphtha from crude running and gasoline reformate, and there are facilities for inhibiting and ethylizing sweetened gasoline. A 380-barrel capacity batch treating plant sweetens kerosine. Chemical storage facilities prepare and store reagents required for these treating plants.





View of Ammonia Plant Showing Extent of Usage of Carbon Steel.

Metals for High-Pressure Hydrogenation Plants

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Metallurgist, Shell Development Company
San Francisco

WHEN processes are started involving high-pressure hydrogenation, the mechanical engineer will be faced with many problems including hydrogen attack, corrosion, erosion, and high-temperature stability of materials.

The purpose here is to review what we know about metals as used by the Shell group of companies and others in lower pressure plants, and, in view of these experiences, to offer ideas as to materials which may be required as high-pressure plants become of increasing importance.

The gases with which we have had some experience are hydrogen, nitrogen, ammonia, and hydrogen sulfide. These gases are inert to most metals at normal temperatures and pressures. At low pressures, the gases can be heated to moderately high temperatures without any damaging effect on metals. Conversely, at normal temperatures these gases can be handled safely in carbon steel at very high pressures, and we find this material to be specified by the Interstate Commerce Commission for transportation in high-pressure cylinders. However, when both heat and pressure are applied, these gases may become violently active in either creating internal damage to the steel or actually corroding steel at a very rapid rate. The effects of these gases on metals as the result of our experiences, when hydrogen gas mixtures are being processed, will be discussed.

Hydrogen

Early experiences in handling of hot hydrogen showed numerous failures, and many reports of these troubles are available. Zapffe[1] has compiled an imposing list of 427 references dealing with various phases of the effects of hydrogen on metals.

The damage produced by exposure of steels to high-pressure hydrogen may be described as decarburization and intergranular cracking. Even though these cracks are so tiny that they become visible only when viewed under a microscope, they are so numerous that their net effect produces a marked deterioration of physical properties, such as tensile strength, yield point, and ductility. A severely attacked piece of steel has a tensile strength in the order of 25,000 psi., as compared to a normal strength of about 60,000 psi.; and the elongation on a test bar is reduced to zero from a normal elongation of about 30 percent in 2 inches. The strength is roughly comparable with that of a weak piece of cast iron.

There actually is no corrosion or wasting away of metal when it has become affected by hydrogen damage. In fact, a slight growth occurs. In one of our plants, tubing (22 feet long) operating in a noncritical stress location and therefore made of carbon steel, becomes about 1 inch longer over an operating period of 5 years. The absence of any appreciable dimensional changes of an affected piece of steel requires inspection methods other than visual or by direct measurement. However, bending, hardness, and macroetch tests readily reveal the presence of any affected areas. The microscope is also used to define clearly the presence of microscopic cracks.

THERE IS prospect that the hydrogenation processes will find increasing application in refinery operations in the not too distant future. These processes may provide economic utilization of residual oil stocks, as well as a method by which coal can be converted into liquid fuels. Accordingly, this present article on materials of construction that are suitable for such plants may have practical value. A number of problems are involved and must be solved if safe operation of high pressure hydrogen apparatus is to be achieved.

Figures 1 and 2 show the appearance of carbon steel before and after exposure to hydrogen at high pressure and temperature. The damaged section shows not only a complete decarburization, but also that small inclusions such as oxides and sulfides have been reduced by this gas while diffusing through the steel.

Figure 3 shows the appearance of a tensile bar taken from a section of low-alloy pipe which had been partially damaged by hydrogen attack. The side of the bar that is cracked and exhibiting no ductility represents the inner side of the pipe in contact with hydrogen. The outer section of the pipe represented by the ductile portion of the bar is still in sound condition. In practice, it is not unusual to find samples of this type. It occurs in borderline temperature-pressure conditions, where the alloying elements in the steel may not be sufficient to render the steel completely resistant to hydrogen. However, because of the temperature gradient across the wall as one proceeds from the hot side, a zone

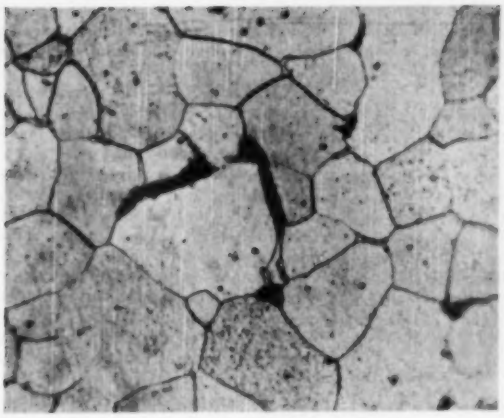


Figure 1. Low-Carbon Steel before Exposure. Shows normal grain boundaries, pearlite areas, and shape of inclusion.

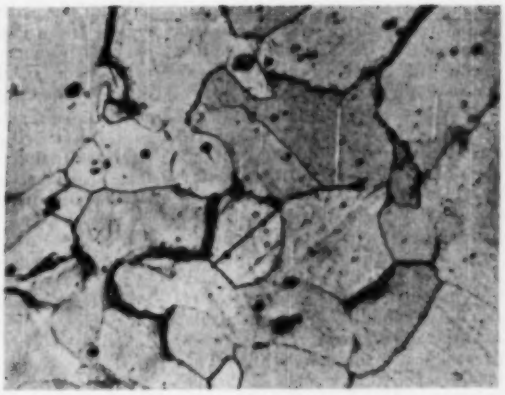


Figure 2. Low-Carbon Steel after Exposure to High-Pressure Hydrogen. Shows cracked grain boundaries, absence of pearlite and appearance of reduced inclusions.
(Time of Exposure, 19,277 hours; temperature, 400-450° C.; pressure, 115-135 Kgs/cm²)

in the cross section is eventually reached where the temperature is such that the alloy is entirely adequate.

In borderline cases, a change of a few degrees in temperature represents the difference between satisfactory performances or gradual failure. In some cases, where hydrogen attack has been found partially extending through the walls of piping or pressure vessels and spare equipment is not immediately available, it has been found expedient to remove the insulation from the affected parts. This lowers the temperature in the wall to stop any further attack and permits the plant to operate until replacement parts can be obtained.

Hydrogen damage at high pressures is attributed to the ability of the hydrogen to permeate the steel, resulting in the formation of methane by the reaction of hydrogen with the iron carbide. The methane which has been formed cannot diffuse out of the steel, and thereby gives rise to high stresses which lead ultimately to cracking at the grain boundaries. That methane is the ultimate reaction product has been demonstrated by F. K. Naumann,[2] who showed that with a pure hydrogen gas entering a carbon-steel tube at high pressures and temperatures, appreciable amounts of methane were obtained at the exit end of the pipe.

The attack by hydrogen is prevented by adding to the steel any of the carbide-stabilizing elements. In ascending order of importance, they are manganese, molybdenum, chromium, tungsten, vanadium, titanium, and columbium. All of the austenitic steels are resistant because of their high chromium content. The noncarbide-forming elements, such as nickel and silicon, have no effect in preventing interior damage to the steel by hydrogen. The presence of impurities such as phosphides and sulphides has a tendency to increase attack; therefore the total amount of these elements should be kept below the minimum required by ASTM specifications.

As mentioned in the previous paragraph, carbide-stabilizing elements have the property of rendering a steel immune to hydrogen attack at high pressures and temperatures. However, plain carbon steel is also widely used and is perfectly safe as a constructional material, provided that the upper limit of temperature is known for a particular pressure condition. These limits have been determined by operators of hydrogenation plants, and as a result of a critical survey covering a wide range of pressures and temperatures, sufficient data have been accumulated to propose operating limits for carbon and alloy steels.[3]

The collected data from operating companies were assembled into chart form; and, by plotting borderline curves between satisfactory and unsatisfactory operating points, a clearer conception was obtained as to the suitability of carbon and alloy steels for a particular pressure-temperature condition. As the result of more experience, several adjustments to the curves were necessary, and a total of 22 revisions to the charts were made during a period of seven years. The latest set of curves is illustrated in Figure 4, and is presented with the expectation that further revisions will be required.

The curves in Figure 4 have been plotted on the basis of hydrogen partial pressure. Some of the earlier charts had been prepared using references based upon the total plant-operating pressures. This led to some misunderstanding of the significance of the lines. As it was realized that hydrogen was the only component of a gas stream which could permeate the steel and create internal damage, all reference points were moved to correspond to the pressure exerted by the hydrogen alone. It is believed that the present form of presentation gives a much clearer idea of the materials to be used for a particular pressure-temperature condition.

The circumstances surrounding the locations of the curves shown in Figure 4 might be described as follows: The high-pressure level for carbon steel (above 2600 psi.) was located as a result of the advice of Standard Oil Development Company and Hercules Powder Company, which have used carbon steel in this temperature region for many years without failure; moreover, metallurgical examination of samples removed from the units showed no damage. The safe operating limits for carbon steel below 2600 psi. were established from the experience of the Shell group, the revelations by Zapffe[1] and Evans,[4] The M. W. Kellogg Company, and Standard Oil Company of California.

It may be of interest to note that, at 600 psi. and 590 F., an unsatisfactory reference point for carbon steel is shown. The data surrounding this failure resulted from an inspection of a

TABLE 1
Hydrogen Damage to Carbon-Steel Piping

Size of Pipe	Wall Thickness, Inches	Percent of Wall Affected
1-inch Threaded Nipple	0.280	0.0
1¼-inch Schedule 160	0.400	8.3
2½-inch Schedule 160	0.555	50.0
6-inch Schedule 160	0.848	35.0
6-inch Schedule 160	0.873	80.0

carbon-steel line which had been in operation in a Shell Oil Company plant for about 2 years. The particular line consisted of 6-inch schedule 160, carbon-steel piping, to which were attached by welding several smaller lines of 1, 1½, and 2½ inch schedule 160 carbon-steel pipe. Ring sections removed from the different sizes of pipe were hot acid-etched, and Table 1 shows the damage to the walls from hydrogen.

These figures are cited to illustrate that variations in the practice of making steel may have a considerable effect on the ability of the particular steel to resist damage by hydrogen. It also indicates that, when plants are being inspected, a number of samples should be taken. In other words, using the foregoing example, if a sample had been taken only from the 1-inch nipple line, the entire line might have been passed as being satisfactory and would soon have failed. This conclusion was also reached by T. C. Evans,[4] who showed that, at 350 psi. and 310 C., some samples of carbon steel were satisfactory, whereas others were severely damaged. In order to build plants to the upper limit of carbon steel, we must use steels from suppliers' stocks which may have a wide divergence of melting practice and, therefore, this material can be used only to the limit of the average quality of steels we can obtain. This has been the basis for the location of the carbon-steel curve.

Particular importance is being given to the upper limit of carbon steel. In hydrogenation plants, an example of which is shown in Figure 5, all of the cold piping and equipment is made of carbon steel. These include the compressor, purification, and some heat-exchange equipment. These pieces of equipment represent a considerable part of a hydrogenation plant, and it is necessary to protect by means of alloy steels only those parts of the plant where the limit for carbon steel is exceeded.

Another example of the wide usage of carbon steel is shown at the top of page 104—an ammonia plant operating at 2140 psi. Viewing the plant from right to left, all of the equipment (excluding low-temperature fractionating apparatus) in the background is constructed of carbon steel with the exception of equipment in the last building on the left. This building contains the catalyst chambers which are made of alloy steel, as are the accompanying exchangers and piping.

The carbon-molybdenum limiting curve has been established from samples taken from hydrogenation plants erected during the recent war. It is noted that no data are at present available for the extremely high-pressure region, and it is possible that the carbon-molybdenum curve may be somewhat altered in this area as the result of more experience.

The 1 percent chrome-molybdenum curve is fairly well established with reference points. It might be stated that a number of chrome-vanadium steels (references 5 and 6 in Figure 4), have been added at the high-pressure end of this curve. No data were available for the chrome-molybdenum steels at these pressures. However, from our experiences at one plant, which had operated at a pressure of 2140 psi., we found that, when the chromium was in the order of 1 percent, chrome-vanadium and chrome-molybdenum steels had about the same resistance. Thus SAE 6120 and SAE 4120 were interchangeable for use as interior bolting materials. It seemed reasonable to insert these reference points to locate the chrome-molybdenum line.

Figure 3. Appearance of Tensile Test Bar from Hydrogen-Affected Low-Alloy Steel Tubing.

(Hours in service, 21,456; Temperature, 400-450° C.; Pressure, 115-135 Kgs/cm². Analysis: C-0.15, Mn-0.50; Si-0.35; Cr-0.80; Mo-0.50)

In view of the equivalent resistance of vanadium and molybdenum when associated with chromium, it is felt that the entire set of curves could equally, or possibly better, apply to the chrome-vanadium steels. The reason for plotting the chart only as chrome-molybdenum steel is because we use large amounts of piping, and chrome-molybdenum analyses are available in many sizes of tube and pipe. It can be mentioned that many high-pressure vessels made of chrome-vanadium steel are giving satisfactory performance in hydrogenation plants.

The 2 percent chrome-molybdenum line is not too well fortified by reference points.

The 3 percent chrome-molybdenum, and the 6 percent chrome-molybdenum lines have been extended only to 6000 psi. At pressures above 6000 psi. and at high temperatures, information gleaned from reports of the technical oil missions covering war-time German experiences disclosed that both 3 percent chrome-molybdenum, and 6 percent chrome-molybdenum had to be fortified with other carbide formers, such as tungsten or vanadium, in order to make them hydrogen-resistant. The reference points for these steels are shown in the upper right-hand portion of the chart. Austenitic chrome-nickel steels could also have been used, but the tonnage required was too great for Germany's economy to take care of the high chromium and nickel contents.

The dashed lines at the tops of the hydrogen-attack curves indicate decarburization. This decarburization is not accompanied by intergranular fissuring, and the steels exhibit ductile properties with slightly lower than normal tensile strength—in this respect behaving much like steels which have been decarburized because of oxidation.

It was mentioned earlier that other elements than chromium and molybdenum also produced a sufficiently stable carbide which rendered a steel immune to hydrogen damage. During this investigation an attempt was made to evaluate the long-time performance of titanium, vanadium, and molybdenum steels when their alloy-to-carbon ratios were in proportion to the amount required to form a stable carbide. For these experiments, sets of small test bars were installed in reaction chambers of several companies. Unfortunately, the

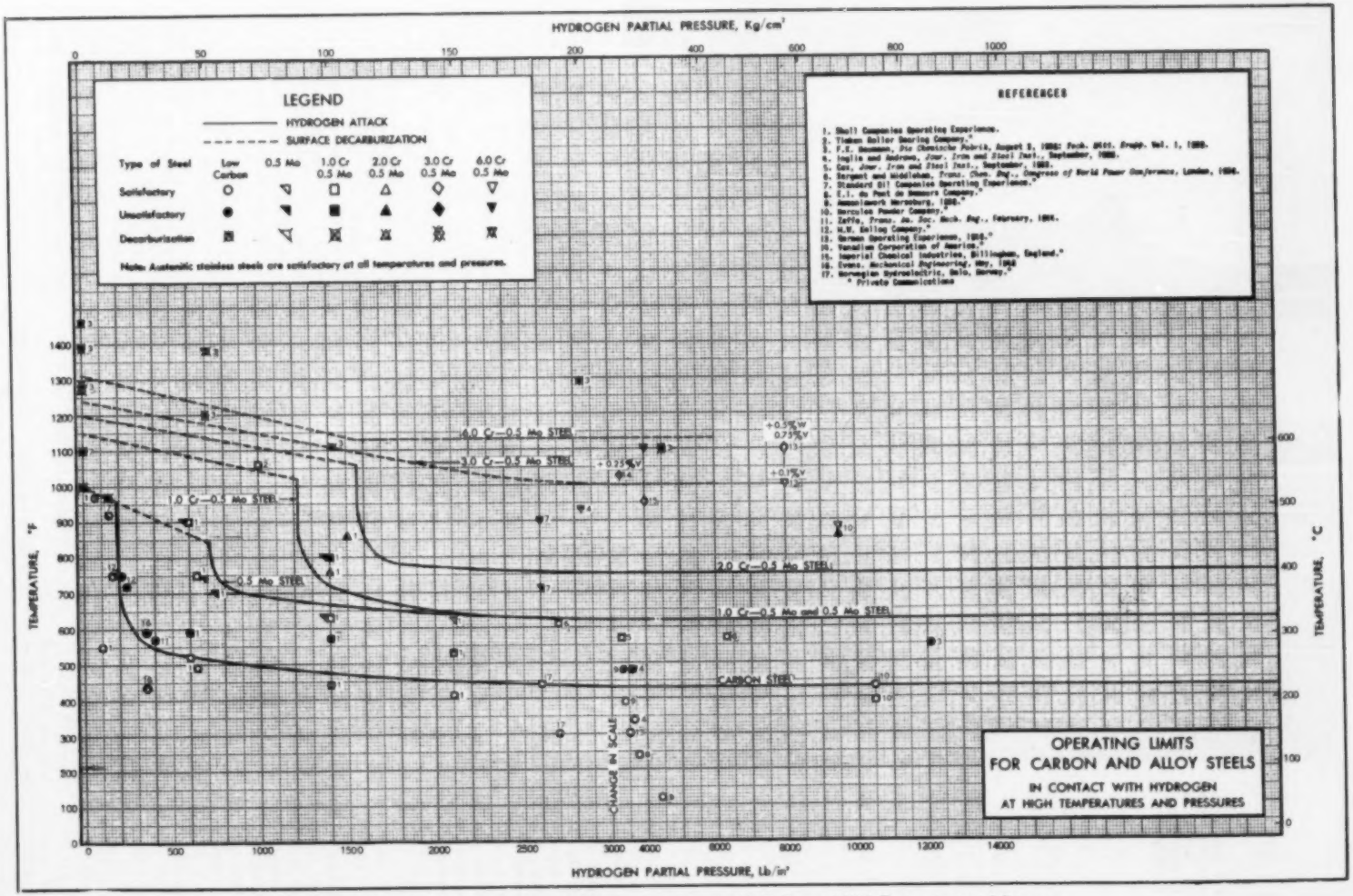

HYDROGEN PARTIAL PRESSURE, Kg/cm²
HYDROGEN PARTIAL PRESSURE, Lb/in²
TEMPERATURE, °F
TEMPERATURE, °C
LEGEND
HYDROGEN ATTACK
SURFACE DECARBURIZATION
Type of Steel
Low Carbon
0.5 Mo
1.0 Cr 0.5 Mo
2.0 Cr 0.5 Mo
3.0 Cr 0.5 Mo
6.0 Cr 0.5 Mo
Satisfactory
Unsatisfactory
Decarburization
Note: Austenitic stainless steels are satisfactory at all temperatures and pressures.
REFERENCES
1. Shell Companies Operating Experience.
2. Timken Roller Bearing Company.*
3. F.E. Bowman, Pic Chemische Fabrik, August 2, 1950; Pack. Mfrs. Progr. Vol. 1, 1950.
4. Inglis and Andrews, Jour. Iron and Steel Inst., September, 1923.
5. Cas. Jour. Iron and Steel Inst., September, 1923.
6. Sargent and Middleham, Trans. Chem. Eng., Congress of World Power Conference, London, 1924.
7. Standard Oil Companies Operating Experiences.*
8. E.I. du Pont de Nemours Company.*
9. Ammoniawerk Merseburg, 1926.*
10. Hercules Powder Company.*
11. Zeits, Trans. Am. Soc. Mech. Eng., February, 1924.
12. M.W. Kellog Company.*
13. German Operating Experiences, 1926.*
14. Canadian Corporation of America.*
15. Imperial Chemical Industries, Billingham, England.*
16. Evans, Mechanical Engineering, May, 1926
17. Norwegian Hydroelectric, Oslo, Norway.*
* Private Communications
6.0 Cr—0.5 Mo STEEL
3.0 Cr—0.5 Mo STEEL
2.0 Cr—0.5 Mo STEEL
1.0 Cr—0.5 Mo STEEL
0.5 Mo STEEL
1.0 Cr—0.5 Mo and 0.5 Mo STEEL
CARBON STEEL
+0.25%V
+0.5%W 0.75%V
+0.1%V
CHANGE IN SCALE
OPERATING LIMITS
FOR CARBON AND ALLOY STEELS
IN CONTACT WITH HYDROGEN
AT HIGH TEMPERATURES AND PRESSURES

Figure 4. Operating Limits for Carbon and Alloy Steels in Contact with Hydrogen at High Temperatures and Pressures

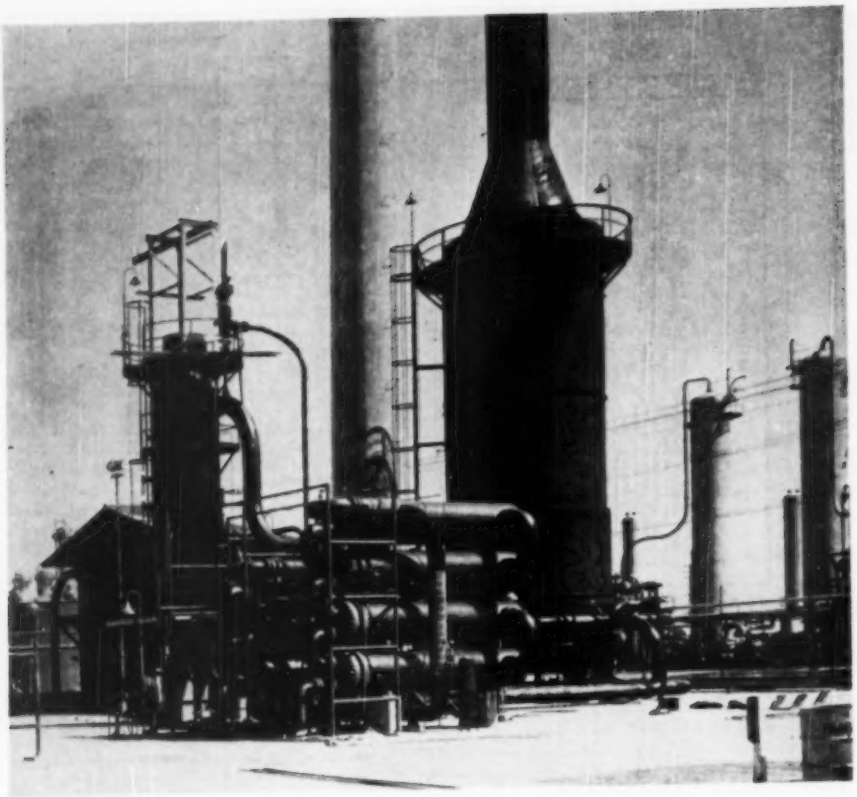


Figure 5. View of Hydrogenation Plant Showing Carbon and Alloy-Steel Heat Exchangers.

majority of operating conditions involved the complicating presence of ammonia, and the bars became nitrided. However, from micro-examinations of the cores of these bars, it was indicated that steels would be free from hydrogen damage at extremely high pressures when the alloy-to-carbon contents were in the following proportions:

Titanium-to-carbon	= 4 to 1
Vanadium-to-carbon	= 5.7 to 1
Molybdenum-to-carbon	= between 30:1 and 60:1

Hydrogen Sulfide and Sulfur

When other corrosives are in the process streams, the problem becomes more complicated, and additional measures may be required in order to fabricate apparatus which will be free from trouble. Our experience with sulfur is as follows: When sulfur is present, either as the element or as hydrogen sulfide, it has the ability to corrode either carbon steel or low-chromium steel when the temperature rises above 675 F. Sulfur corrosion is a scaling process and the ultimate reaction product is a layer of iron sulfide. If this layer becomes hard and clings tightly to the steel, it offers some resistance to further corrosion. This effect has been noted on transfer lines. However, in turbulent regions such as furnace piping and heat-exchanger tubes, the scale is jarred loose, with a consequent increase in corrosion.

The corrosion rate rises in relation to the amount of the sulfur in the stream, but a definite recommendation cannot be made as to the amount of alloy required to resist a given attack. As an example of the difference in metal composition required for varying sulfur contents, we might again refer to the heat exchangers shown in Figure 5. Shell Oil Company had constructed two of these plants. In a plant on the West Coast which handles sweet crudes, the hot exchangers were made with 1 percent chromium—0.5 percent molybdenum tubing. After four years the tubing in the hot exchangers had become affected by sulfur corrosion to the extent that they had to be replaced. The use of 5 percent chromium—0.5 percent molybdenum tubing was considered adequate as a replacement material for a long life.

In a duplicate plant which had been erected in the Midwest and which was processing sour Texas crudes, it had been deemed advisable to construct the original tube bundles of 5 percent chromium, 0.5 percent molybdenum. These bundles failed after only six months in operation; and, for replacement tubing, 18 percent chromium—8 percent nickel was required. The 18—8 tubing has now been in service for four years, and will probably be adequate. For complete resistance to sulfide attack, the high-alloyed steels, such as 12 percent chromium or 18 percent chromium—8 percent nickel, are required. These metals are frequently used as liner materials for reaction vessels and exchangers.

Nitrogen

Where nitrogen is also present with the hydrogen gas, it has been found that nitriding begins at temperatures above 850 F. in a Shell ammonia plant operating at 2140 psi. This nitriding is typified by a thin, hard, brittle layer, and it occurs on steels containing more than 2 percent chromium. Austenitic stainless steels are similarly affected. Its effect has not been of too great a consequence as it consists of a thin,

hard, brittle case which usually extends to a depth no greater than 1/32 inch, even after prolonged exposure. Piping and heavy forgings have never failed as a result of nitriding.

However, a need exists for more information as to materials which will resist both hydrogen and nitrogen. Thin pieces of equipment such as expansion bellows, gaskets, heat-exchanger jackets, and the like, cannot operate with hard, brittle layers present. Experiments are now in progress to determine the resistance to nitriding and hydrogen attack of high-nickel alloys such as Inconel, Hastelloys B and C, 15Cr-35Ni, and some of the special alloys developed during the war for high-temperature use in gas turbines.

For protection against nitriding, an alloy containing 16 percent chromium, 15 percent nickel, 3 percent silicon, and 0.4 percent carbon has been reported as satisfactory at 950 F. and 12,000 psi. It is also understood that a high-nickel alloy containing 57 percent nickel, 12 percent chromium, and 1.7 percent tungsten is used for converters in the Claude process of synthesizing ammonia. The life varies between 2000 and 20,000 hours, depending upon the quality of the casting.

Ihrig[5] recently reported the results of nitriding tests on chromium and austenitic stainless steels after being exposed to hydrogen-nitrogen mixtures at 13,000 to 15,000 psi., and at temperatures from 204 to 593 C. He concluded that although the austenitic chromium-nickel steels are the best for use at high pressures of hydrogen and nitrogen, care should be taken in the design of high-pressure vessels for such use, and advised that samples should be taken periodically to determine whether attack has been progressive.

TABLE 2
Metals Used in Carbon Monoxide-Hydrogen Tests

METAL	ANALYSIS											
	C	Si	Mn	P	S	Cr	Ni	Mo	Ti	Cu	Fe	Sn
Mn Bronze	...	...	5.1	...	...	0.3	...	...	...	94.1	0.2	0.1
FF30	0.35	...	...	...	...	30.25	0.20	...	...	...	...	...
NCT3	0.09	2.4	0.7	0.23	Sp.	25.2	20.1	...	...	...	...	...
V2A-extra	0.085	...	...	...	...	18.10	8.75	...	0.27	...	...	...
V2A-extra	0.09	...	...	...	...	17.3	8.22	...	0.59	...	...	...
V2A-normal	0.085	...	...	...	...	17.55	9.30	...	...	...	...	...
V4A	0.106	...	0.40	...	...	17.5	9.20	2.30	...	...	...	...
V6A	0.10	0.5	0.34	...	...	17.9	8.9	...	...	2.4	...	...
CF87212	0.49	0.63	17.8	...	...	2.59	0.05	...	...	...	...	...
V17F	0.08	0.60	0.58	...	...	16.2	0.20	...	...	...	...	...
V13F	0.085	0.35	0.38	0.021	0.006	13.7	0.37	0.34	...	...	...	...
V5M	0.17	0.46	0.52	...	...	13.9	0.57	0.24	...	...	...	...
V5	0.12	0.25	0.75	...	...	3.36	0.08	0.30	...	...	...	...
Low-carbon Steel	0.09	Sp	...	0.016	...	...	...	...	...	...	...	...

Carbon Monoxide

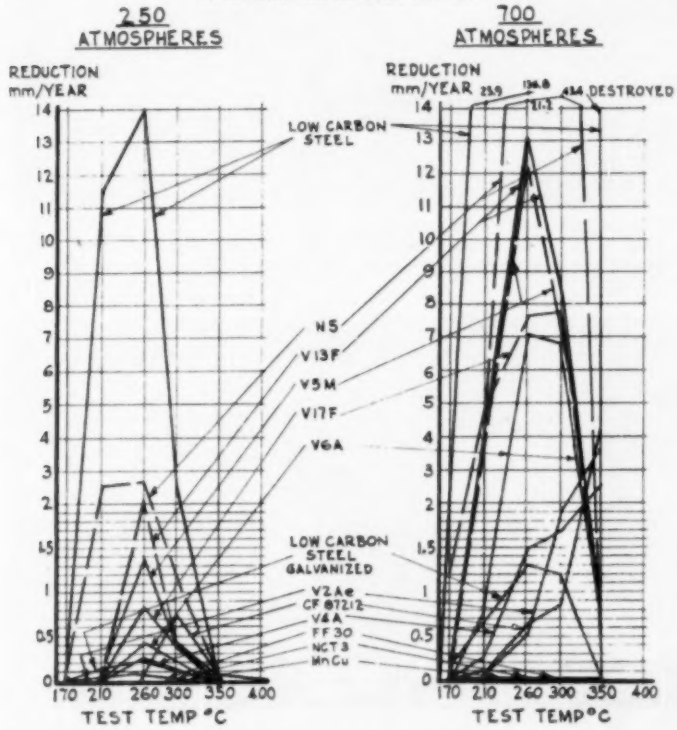
Another element not ordinarily considered to have any effect at low pressures but which develops into a severe corrosive at high pressures in the presence of hydrogen is carbon monoxide. This gas at ordinary pressures is inert to most constructional materials even up to quite high temperatures. However, at high pressures, the corrosion is of such severity that special materials must be used, even though the temperature is quite low. While we have had no practical experience with carbon monoxide, experiences in Germany are summarized from several documents microfilmed by the Technical Oil Mission, describing pilot and commercial-plant operations wherein carbon monoxide and hydrogen at high pressures were being handled.

Figure 6 summarizes pilot-plant data from sheets obtained from the I. G. Farbenindustrie Ammonia Works (1943 I) Merseburg. The analyses of the metals tested are shown in Table 2. In an effort to evaluate possible metals of construction for high-pressure units containing mixtures of carbon monoxide and hydrogen, the chart shown in Figure 7 has been prepared from the data in Figure 6.

The tests were made in a 50/50 CO/H_2 mixture at pressures of 250 and 700 atmospheres. An extremely severe corrosive condition was found to exist at both high and intermediate pressures at a temperature of 260 C. (500 F.) At this temperature mild steel corroded at rates up to 0.550 inch per year at 250 atmospheres and 5.4 inches per year at 700 atmospheres Above and below 500 F., the corrosion rate dropped off rapidly. In preparing Figure 7 it was considered that carbon monoxide was the only portion of the gas responsible for the corrosion, therefore the pressures are indicated as the partial pressure of carbon monoxide.

A summary report covering the experiences gained from the commercial-plant operations in Ludwigshafen shows among other data that diffusion-galvanized N5 steel (5 percent chromium) has proved very satisfactory

Figure 6. Experiments for CO Attack.
Gas: $CO/H_2 = 50:50$ percent, $5m^3/Hr.$ — 72-Hour Test. Reference: Technical Oil Mission, Reel 87, Bag 3979, Item 115, Pages 1846-1860.



in reactors. No change was observed on the galvanized surface after 310 days of operation. The resistance to CO corrosion by galvanized steel, however, was evident only up to 250 atmospheres, pressure as tests at higher pressures of 700 atmospheres showed a high corrosion rate when temperatures rose above 180 C. (356 F.).

In their experimental work with high-chromium-steel samples, these pieces showed a chromium-rich surface layer of great hardness due to the "diversion of iron into the carbonyls." In case that this chromium-rich layer should prove to provide protection during the operations, it would be possible that V13F steel (13 percent Cr), which showed great resistance to CO attack, could be utilized for the commercial operation.

As a result of their tests it was concluded that carbon monoxide is very corrosive to ordinary constructional materials at high pressures when the temperature is between 300 F. and 650 F. In this range, special metals must be used.

High-Temperature Stability

High-temperature stability will be required mainly to resist oxidation from furnace gases, hydrogen attack, and deformation from high stresses. It can be mentioned that from a survey of operating plants, most of the hydrogenation catalytic reactions occur at temperatures not over 600 C. (1100 F.) If such should be the final limit, many steels are now made which are entirely suitable for resisting oxidation. However, as the 1100 F. temperature is approached, strengths rapidly drop and with the high stresses developed by the high pressures, many materials are unsuitable because of the necessity for providing an unreasonably thick wall. For present plants, the austenitic steels suffice. In the future it may be possible to use some of the highly alloyed gas-turbine materials if they become available in tubular form.

Conclusions

1) In order to produce damage to the structure of carbon steel by hydrogen, both high pressures and high temperatures are required.

2) Carbon steel varies in its resistance to attack with the manufacturing methods; and, in order to build commercial plants, limits for this material should be at a level where steel in its average condition will be adequate.

3) For protection against damage to steel by hydrogen, relatively small amounts of carbide-stabilizing elements are required.

4) When other corrosives are present in the process streams, measures for protection against these elements should be taken in addition to those required for resistance to hydrogen damage.

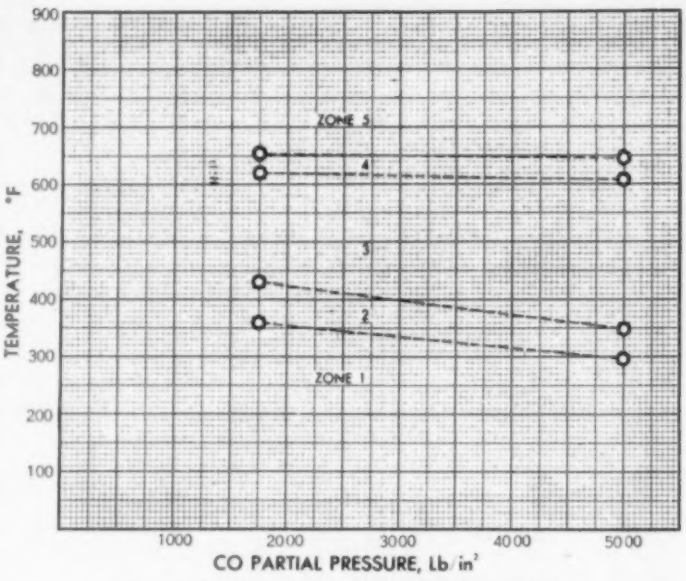


Figure 7. Corrosion Resistance of Metals to Carbon Monoxide

LEGEND: 30Cr steel, 25Cr-20Ni steel, and manganese bronze (5% Mn)—Satisfactory in all zones; 13Cr and 17Cr steels—Satisfactory in zones 1, 2, 4, and 5; low carbon steels and 5Cr steel—Satisfactory in zones 1 and 5; 18Cr-8Ni (types 321 and 316)—Satisfactory in zones 1 and 2, and low-pressure end of zones 3, 4 and 5. REFERENCE: Technical Oil Mission—Reel 87, Bag 3979, Item 115, Pages 1846-1860.

REFERENCES

1 "Boiler Embrittlement," by C. A. Zapffe, Trans. ASME, vol. 66, 1944, pp. 81-126.

2 "Steels for Fuel Plants," by F. K. Naumann, *Chemische Fabrik*, vol. 11, 1938, pp. 265-284.

3 "Hydrogenation Plant Steels," by G. A. Nelson, American Petroleum Institute Proceedings, Section 3, Division of Refining, 14th Mid Year Meeting, April 4-7, 1949, pp. 163-272.

4 "Hydrogen Attack on Carbon Steels," by T. C. Evans, *Mechanical Engineering*, vol. 70, 1948, pp. 414-416.

5 "Attack of Hydrogen-Nitrogen Mixtures on Steels," by H. K. Ihrig, *Industrial and Engineering Chemistry*, vol. 41, 1949, pp. 2516-2521.

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During the progress of this work, the metallurgical laboratories of a number of the co-operating companies performed many tests; and the author is grateful for their assistance. Thanks are expressed to the following individuals for their co-operation and advice, which were freely given; the companies they represent are also thanked for release of their data: H. D. Newell, Babcock and Wilcox Tube Company; J. E. Wilson, Climax Molybdenum Company; W. B. Kennedy, Columbia Steel Company; H. L. Maxwell, E. I. du Pont de Nemours and Company; C. E. Prochter, Hercules Powder Company; D. B. Rossheim, M. W. Kellogg Company; P. D. McElfish, Perry Kilsby, Incorporated; E. C. Wright, National Tube Company; M. Voogd and L. M. Roberts, Shell Chemical Corporation; A. J. Johnson, Shell Development Company; R. R. Bacon, A. E. Collins, and C. G. Brown, Shell Oil Company; M. A. Schell, A. O. Smith Corporation; K. V. King, Standard Oil Company of California; M. S. Northrup, Standard Oil Development Company; A. G. Bagsar, Sun Oil Company; C. L. Clark, Timken Roller Bearing Company; G. F. Comstock, Titanium Alloy Manufacturing Company; D. L. Edlund, Vanadium Corporation of America.

NOTE

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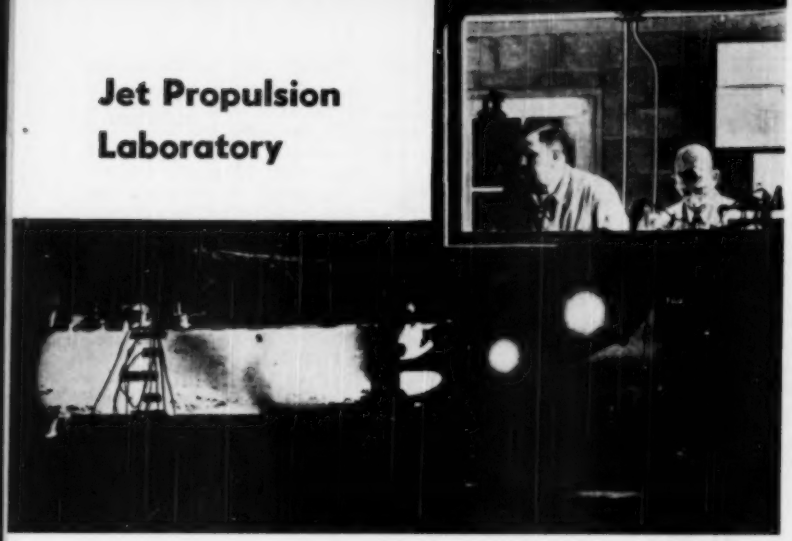
* * *

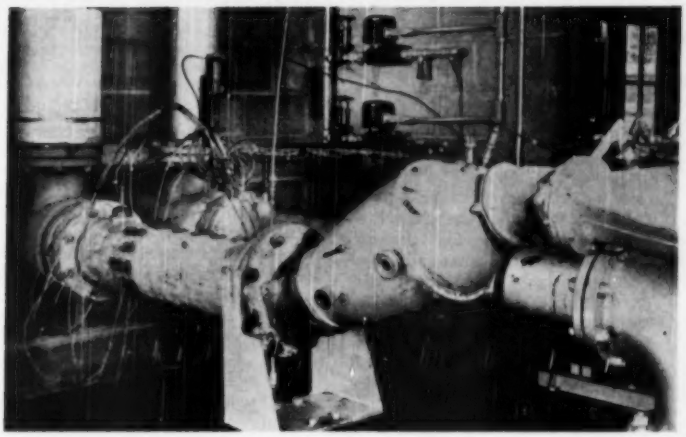
Jet Propulsion Laboratory



THE Texas Company's new jet propulsion laboratory has gone into operation at the company's research center at Beacon, N. Y. It is believed this is the first large industrial jet laboratory to be financed entirely from private funds. Heretofore, most U. S. jet research has been sponsored by the government and directed toward military purposes.

In photo at left, exhaust gases from gas turbine combustion, traveling at speeds of 1000 feet per second and reaching temperatures of 1600° F., turn exhaust pipe into brilliant cherry red color in nighttime jet research. Specially constructed quartz windows permit Texaco scientists to study combustor interior.

The new laboratory can be used to test not only petroleum components but a wide range of organic and inorganic chemicals which possess remarkable power characteristics.



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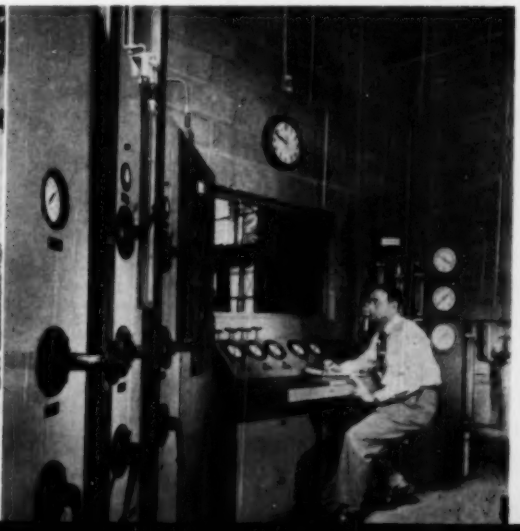
Close-Up of Combustor Test Section. At left is a Pratt and Whitney combustor installed in the test cell. Engines in which combustors of this type are used develop over 5000 pounds thrust and are among the most powerful in production. They are installed in high-performance aircraft such as the Navy's Grumman Panther.

The piping at the left is a heat exchanger which cools the exhaust gases from 1400° F. and at the same time heats the inlet air to the combustor. The wiring is for the 18 thermocouples which are used to measure combustor outlet temperatures.

Lab Building. Below: Combustor section (left) and compressor room (right) are equipped with wall-size rolling doors to permit easy installation of new equipment and to facilitate test operation. Tank in foreground serves to cool and slow down high velocity exhaust gases.

Texaco's Jet Lab Instrument Panel. Below: simplified automatic control system permits single operator to conduct combustion efficiency tests over a wide range of engine operating conditions. Lab will simulate high speed flight at altitudes up to 60,000 feet.



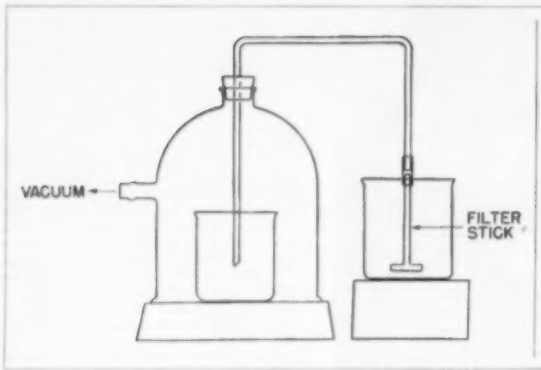


Figure 7. Apparatus for Microfiltration Using Filter Stick and Reduced Pressure.

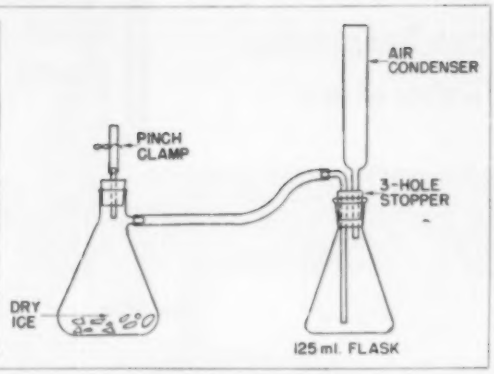


Figure 8. Apparatus for Microtitration of Tin Under Carbon Dioxide Atmosphere

Reduced-Scale Methods for Micro and Semimicro Analysis

PART II

THOMAS D. PARKS and LOUIS LYKKEN
Shell Development Company, Emeryville, Calif.

In the August issue Part I of this article took up organic analysis. Part II, herewith, discusses reduced scale methods, so desirable or necessary in petroleum research laboratories, for the determination of 12 common inorganic elements and will give detailed procedures for silica, calcium, tin, and nickel.

Inorganic Analysis

Silica

The determination of silica depends on its selective volatilization with hydrofluoric acid in a platinum dish from the residue obtained by double dehydration of the sample with mineral acids in a Pyrex beaker. Details of the procedure follow:

Weigh 10 to 50 mg. of sample into a 30-ml. Pyrex beaker. Add 3 ml. of water, 2 ml. of 12 N hydrochloric acid, and 2 ml. of concentrated nitric acid; evaporate to near dryness (moist crystals) on a hot plate. Remove from hot plate and allow to cool slightly; add 5 ml. of 60 percent perchloric acid and evaporate to dryness. Transfer to a cool muffle furnace (below 300° C.) and heat at 550 ± 25° C. for 30 minutes. Moisten with acid, take up the residue in distilled water, heat to near boiling, and filter while hot. Wipe the inside of the beaker with filter paper, combine with precipitate, and place in a 20-ml. platinum dish. Place in cool muffle furnace with door open and burn off paper. Bake in muffle at 1100° C. for 30 min. Cool, weigh, and add 1 ml. water, 1 ml. 48 percent hydrofluoric acid, and 5 drops of 36 N sulfuric acid. Heat on hot plate to sulfur trioxide fumes, cool, add 2 ml. water, and heat until no fumes are given off. Weigh on microbalance; from loss of weight calculate percent silica in sample. Correct for blank obtained on all reagents used.

Calcium

Small amounts of calcium are determined by titration with ceric perchlorate following precipitation as calcium oxalate. The titration is carried out at room temperature using Nitro-Ferroin indicator. The precipitation is made under controlled conditions on a solution which has been electrolyzed at the mercury cathode to remove interfering metal ions. Metal ions, not removed by electrolysis (such as barium and aluminum) and phosphate ions interfere. The details of the procedure are given below; the filtration technique is illustrated in Figure 7.

By suitable procedure, obtain no more than 2 mg. of calcium in a small volume of dilute acid solution. Transfer to a 50-ml. beaker, adjust the volume to 5 ml., heat to 90° C., add 5 ml. of hot filtered 5 percent ammonium oxalate solution. Add 1 drop of methyl orange indicator solution and a small iron-in-glass agitator. Place the beaker on a magnetic stirring device, and stir gently. Precipitate calcium oxalate by the dropwise addition of 15 N ammonium hydroxide, to the hot solution, until the indicator is about to change color. Add 8 N ammonium hydroxide dropwise until the color matches that of 1 drop of methyl orange in 10 ml. of 0.1 N potassium acid phthalate (approx. pH 4). Allow to stir 5 to 10 min., remove from stirrer, and allow to cool undisturbed for 30 minutes. Filter through a porcelain filterstick, washing ten times with 1-ml. portions of ice water. Dissolve precipitate and transfer through filterstick to a 50-ml. Erlenmeyer flask with hot 1.5 N perchloric acid. When cool, titrate with 0.01 N ceric perchlorate using 5 drops of nitro-ortho-phenanthroline as indicator. Subtract indicator blank and calculate percent calcium in sample.

Magnesium

Magnesium is often determined on the filtrate from the precipitation of calcium. The well-known ammonium phosphate method is employed, in which the magnesium is weighed as the ammonium phosphate hexahydrate.[6]

Tin

Small quantities of tin are determined conveniently by titration of stannous ion with iodine in a solution free from nitrate, tungsten, molybdenum, and vanadium ions. The iodine solution is standardized against a weighed amount of pure tin. The titration is carried out under an atmosphere of carbon dioxide at ice temperature. The apparatus is shown in Figure 8 and details of the procedure follow:

Obtain in a 125-ml. Erlenmeyer flask, an aqueous solution free from interfering ions and containing 0.6 to 24 mg. of tin. Add 1 to 1.5 ml. of 36 N sulfuric acid, 10 ml. of 12 N hydrochloric acid, 2 g. of test lead, and dilute to 30 ml. with distilled water. Close the flask with a 3-hole stopper containing a gas-inlet tube, extending to the bottom of the flask, and a vertical condenser tube; close the third hole with a solid glass rod. Pass a slow stream of carbon dioxide through the flask, heat to boiling, and boil gently for 30 to 40 minutes. Cool in an ice bath to 0 to 5° C. While continuing the flow of carbon dioxide, remove the plug from the third hole, add 1 ml. of starch solution, and titrate rapidly with 0.01 N iodine solution to the first permanent light blue end point.

Phosphorus

An adaptation of the volumetric

phosphorus method of Winter[27] is used for micro amounts (0.5 to 5 mg.) of phosphorus. After obtaining the precipitate in the usual way, it is collected in filter paper and washed with distilled water. The filter paper with the precipitate is transferred to a micro-Kjeldahl distillation unit, caustic is added, and the ammonia is distilled with steam. The ammonia is received in 5 ml. of a 2 percent boric acid solution and titrated with 0.01 N hydrochloric acid to the end point of a mixed indicator prepared by adding 2 ml. of 0.1 percent methyl red in ethanol to 10 ml. of 0.1 percent bromcresol green in ethanol.

Aluminum

Small amounts of aluminum are determined in several ways. In a recent paper, sodium carbonate fusion was recommended for the separation of aluminum from many interfering elements prior to its determination by ultraviolet, colorimetric, or polarographic means.[20] To these three, all of which depend on the reaction of aluminum with 8-hydroxyquinoline, can be added the classical gravimetric micromethod of Benedetti-Pichler.[4] For general application, the colorimetric oxine-extraction method is used. Details of the procedure are given below; a calibration curve is shown in Figure 9.

To a solution containing 0.010 to 0.150 mg. of aluminum, add 2 ml. of 2 N ammonium acetate and add acid or base until the pH is between 4.3 and 4.6, as measured by a pH meter. Transfer to a separatory funnel and extract with 20 ml. of 1 percent oxine solution in chloroform. Make up the extract to 50 ml. in a volumetric-flask with the extracting solution, and measure the absorption of the solution at 395 mμ on a spectrophotometer. Determine the amount of aluminum from a previously prepared calibration graph.

Sodium and Potassium

Small amounts of sodium or potassium are determined by the polarograph when alone in solutions or after careful removal of interfering ions; when both sodium and potassium are present, a total alkali value is obtained with some degree of accuracy.[26] The use of a flame photometer[5,7] affords a more rapid determination, and serves to distinguish between sodium and potassium and to determine each. Since some cations, anions, and organic solvents tend to interfere,[17] it is generally necessary to purify the solution somewhat. The degree to which this is necessary depends on the type of flame photometer used. For those instruments measuring the intensity of the flame color directly, organic materials are removed, heavy metals are separated by electrolysis at the mercury cathode,[16] and the alkaline earths are removed, if necessary, by carbonate precipitation. Less attention is paid to these factors when using the internal standard comparison instrument.[7] Calibration curves for sodium and potassium using a Perkin-Elmer Flame Photometer Model 52A and the internal standard procedure, are shown in Figure 10.

Silver

To determine small amounts of silver in used lubricating oils, the oil is ashed in a platinum dish at 550° C., the silver is leached from the residue by heating with concentrated ammonium hydroxide, and the silver ion is determined by gravimetric precipitation as silver iodide, or titrated amperometrically with potassium iodide solution at a rotating platinum electrode.[19]

Nickel

Small amounts of nickel are determined in several ways. Traces of nickel are conveniently determined colorimetrically with dimethylglyoxime. Milligram quantities are determined by the polarograph. Micro and semimicro amounts are determined on reduced scale by gravimetric precipitation with dimethylglyoxime; the details of this procedure are given below. The two types of micro filtersticks used are illustrated in Figure 11.

Weigh 5 to 50 mg. of sample into a 20-ml. platinum dish. Add 1 ml. each of concentrated nitric and sulfuric acids and heat on a hot plate to sulfur trioxide fumes. (If silica is present, cool, add 1 ml. water, 1 ml. of 48 percent hydrofluoric acid, and heat to fumes. Cool, add 1 ml. of water and again heat to fumes.) Add 5 ml. water, neutralize with dilute ammonium hydroxide, and make just acid to methyl red with 6 N hydrochloric acid. Add 100 mg. of citric acid, dissolve, and add ammonium hydroxide until strongly ammoniacal. Filter the solution through a cotton-paper filterstick into a tared, thin-wall 20-ml. beaker containing an iron-in-glass agitator.

(**Note.** A glass filterstick is included in the tare weight of the beaker but it is kept separate during precipitation.)

Add 1 ml. of 1 percent dimethylglyoxime for each 2.5 mg. of nickel, plus a slight excess. Agitate with magnetic stirring, then digest (without boiling) for 30 minutes on a hot plate. Cool, filter through glass filterstick, and wash with dilute ammoniacal solution. Dry at 110° C. for 30 minutes, cool, and weigh.

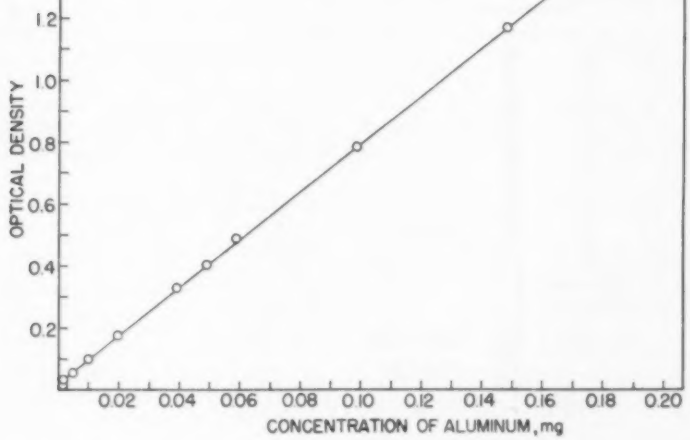
Copper and Iron

Colorimetric methods are widely used for the determination of small amounts of copper and iron in new and used lubricating oils.[12] However, it is preferable to use an amperometric method in which copper and iron are titrated with standard dichromate solution after reduction in a silver reductor.[15] The method provides for the determination of copper or iron or both; total reducing power of the solution is a measure of copper and iron, and the reducing power of the aerated solution gives a measure of iron only. It is sensitive, accurate, and requires little sample preparation because other ions normally present in used lubricating oils do not interfere.

Lead

Lead is often associated, in engine deposits, and residues from oil tests, with metals such as calcium which cause appreciable errors when the lead is precipitated as the sulfate in alcoholic solution. Many interferences are eliminated by the use of a chromate precipitation, similar to that described

Figure 9. Calibration Curve for Chloroform-Oxine Extraction Method



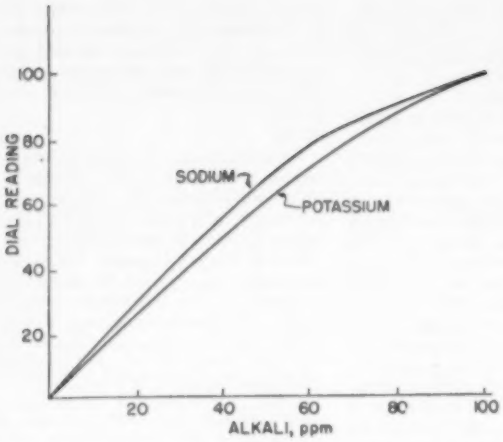


Figure 10. Calibration Curves for Sodium and Potassium by Internal Standard Procedure Using Perkin-Elmer Model 52A Flame Photometer.

by Gordon and Burdett,[9] followed by solution of the precipitate and amperometric titration of the dichromate with standard ferrous ammonium sulfate solution using a rotating platinum electrode at a potential of +1.0 volt.[11]

Zinc

Zinc is sometimes determined as the oxide after precipitation as zinc sulfide.[12] It is conveniently determined by the polarograph after separation of zinc from iron by ammonium hydroxide precipitation.[24] Amounts of zinc from 0.1 to 5.0 mg. can be determined conveniently in this way.

Discussion

Many inorganic samples originate in motor tests or corrosion studies and consist of scrapings or deposits of unknown compositions. A preliminary spectrographic examination is useful to indicate the major constituents and possible interferences in the required analyses. Each analysis becomes a separate problem with variations being made in the method to accommodate the particular conditions of insolubility, inhomogeneity, and interferences. It is often necessary to take the entire sample into solution and use aliquots for the separate analyses. Mercury cathode electrolysis is widely used in the preparation of solutions for the determination of those elements not removed in the process, such as calcium, barium, aluminum, vanadium, sodium, potassium, etc.[10]

Where possible, use is made of methods which are specific and rapid, and which require a minimum of sample preparation. A microbalance is used when it is necessary to weigh samples or precipitates of less than 25 mg. A well-calibrated analytical balance is used for weighing samples above 25 mg. Methods which have volumetric or instrumental end points (amperometric, colorimetric, etc.) are used where possible as they are generally more sensitive and more rapid than gravimetric procedures. For example, calcium is determined by titration with ceric perchlorate, phosphorus by titration of ammonia, aluminum by a colorimetric measurement, and lead by amperometric titration.

The methods for the determination of silver are quite accurate and precise. As seen in Table 2, both the amperometric and gravimetric procedures give satisfactory results for silver in oils containing maximum expected amounts of aluminum, barium, cadmium, calcium, copper, iron, lead, magnesium, tin, zinc, chlorine, bromine, sulfur, and phosphorus.

Tests with the amperometric-chromate method for lead demonstrated that the method was capable of determining as little as 10 micrograms of lead in typical samples encountered.

The most uncertain part of Winter's ammonia distillation method[27] is the constancy of the nitrogen to phosphorus ratio of the yellow ammonium molybdiphosphate precipitate. However, several tests made on known samples confirmed the previous finding of Winter that the ratio was consistent within the limits of error.

Figure 11. Typical Filter Sticks Used in Microanalysis.

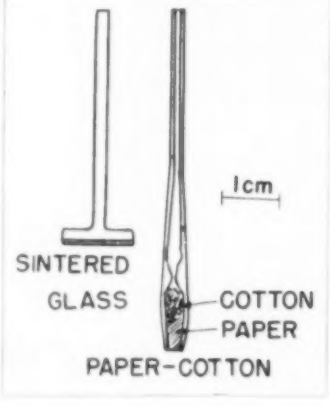


TABLE 2

Recovery of Silver Metal Added to Metal-Containing Lubricating Oils by Amperometric and Gravimetric Procedures

SAMPLE	Silver Added, mg.	Silver Found, mg.	
		Amperometric	Gravimetric
21-A[a]	1.81	1.82	1.78
	1.92	1.92	1.91
23-A[b]	1.56	1.51, 1.53	1.61, 1.63
	1.81	1.81	1.81
	1.84	1.81	1.91
	0.78	0.77, 0.73	0.76, 0.74
White Oil	0.36	0.39, 0.36	.....
	0.44	0.43, 0.44	.....

[a] **Elements present:** Barium, calcium, chlorine, iron, lead, copper, zinc, and phosphorus.

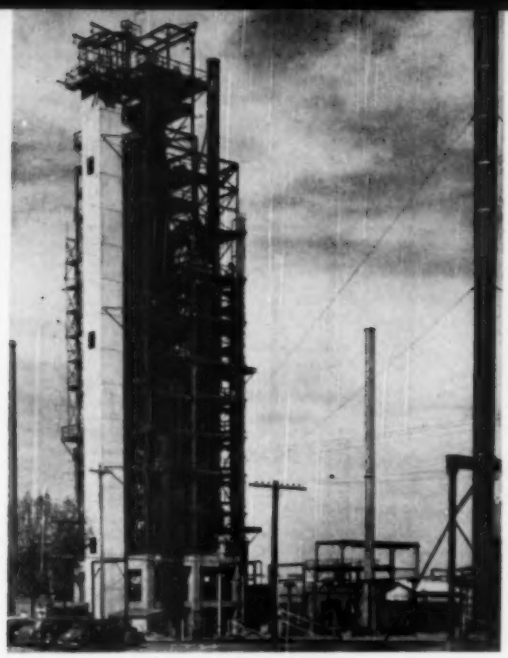
[b] **Elements present:** Barium, calcium, chlorine, lead, magnesium, phosphorous, sodium, sulfur, tin, zinc, cadmium, copper, iron, potassium, silicon.

ACKNOWLEDGMENT

The authors wish to acknowledge the work of a number of their colleagues who, over a period of years, have assisted in the development of many of these methods.

LITERATURE CITED

1 ASTM Standards on Petroleum Products and Lubricants, D664-46T, 341 (1947).
2 Ibid., D939-47T, 499 (1947).
3 Barnes, R. B., Richardson, D., Berry, J. W., and Hood, H. L., Ind. Eng. Chem., Anal. Ed., **17**, 605, (1945).
4 Benedetti-Pichler, A. A., Mikrochemie, Pregl-Festschr., **9** (1929).
5 Benedetti-Pichler, A. A., "Microtechnique of Inorganic Analysis," New York, John Wiley & Sons, Inc., 1942.
6 Benedetti-Pichler, A. A., and Schneider, F., Mikrochemie, Emich-Festschr., **8** (1930).
7 Berry, J. W., Chappell, D. G., and Barnes, R. B., Ind. Eng. Chem., Anal. Ed., **18**, 19 (1946).
8 Foulke, D. G., and Schneider, F., Ibid., **12**, 554 (1940).
9 Gordon, B. E., and Burdett, R. A., Anal. Chem., **19**, 137 (1947).
10 Kirk, P. L., Mikrochemie, **16**, 13 (1934).
11 Kolthoff, I. M., and May, D. R., Ind. Eng. Chem., Anal. Ed., **18**, 208 (1946).
12 Lykken, L., Fitzsimmons, K. R., Tibbetts, S. A., and Wyld, G., Petroleum Refiner **24**, No. 10, 405 (1945).
13 Lykken, L., Porter, P., Rullffson, H. D., and Tuemmler, F. D., Ind. Eng. Chem., Anal. Ed., **16**, 219 (1944).
14 Lykken, L., and Rolfson, F. B., Ibid., **13**, 653 (1941).
15 Marasco, M., Ind. Eng. Chem., **18**, 701 (1926).
16 Parks, T. D., Johnson, H. O., and Lykken, L., Anal. Chem., **20**, 148 (1948).
17 Parks, T. D., Johnson, H. O., and Lykken, L., Ibid., **20**, 822 (1948).
18 Parks, T. D., and Lykken, L., "Determination of Copper and Iron in Oils by Amperometric Titration," in preparation.
19 Parks, T. D., and Lykken, L., "Determination of Small Amounts of Silver in Lubricating Oils by Gravimetric and Amperometric Methods," in preparation.
20 Parks, T. D., and Lykken, L., Anal. Chem., **20**, 1102 (1948).
21 Penther, C. J., and Rolfson, F. B., Ind. Eng. Chem., Anal. Ed., **15**, 337 (1943).
22 Petersen, J. W., Hedberg, K. W., and Christensen, B. E., Ibid., **15**, 225 (1943).
23 Pregl, F., and Roth, H., "Quantitative Organische Mikroanalyse," 5th Edition. Vienna, Springer-Verlag, 1947.
24 Reed, J. F., and Cummings, R. W., Ind. Eng. Chem., Anal. Ed., **12**, 489 (1940).
25 Smith, D. M., and Bryant, W. M. D., J. Am. Chem. Soc., **57**, 841 (1935).
26 Weaver, J. R., and Lykken, L., Anal. Chem., **19**, 572 (1947).
27 Winter, P. K., "A New Method in the Determination of Phosphorus," Presented before the Division of Analytical and Micro Chemistry at the 113th Annual Meeting of the American Chemical Society in Chicago, April, 1948.



THE PHOTO—Main structure of the TCC unit (Socony-Vacuum Oil Company, Inc., Casper, Wyo.) includes reactor and regenerator, catalyst storage and handling equipment, and the main fractionating column.

Test Run Gives Data On TCC Commercial Operation

UPON completion of the first full year of liquid feed operation of the T.C.C. at the Socony-Vacuum Oil Company's refinery at Casper, Wyoming, an over-all refinery check run was conducted. This check run extended over a period of two weeks during which time all distillation and cracking facilities were operated under uniform conditions equivalent to the average of normal refinery operations. The results of this check run were reported by the refinery engineering department of Socony's White Eagle division at Augusta, Kan. This department is headed by Emory M. Skinner, chief refinery engineer, White Eagle Division. Plant manager of the Casper refinery is E. T. Pummill. C. A. Goodnight is operating superintendent and C. L. Allison technical director.

THE oil processing facilities at the Casper refinery consists of two conventional two stage, atmospheric-vacuum crude oil distillation units, a TCC cracking unit, vapor recovery and UOP catalytic polymerization unit. The operation of these units is so integrated as to behave substantially as a combination unit.

During this check run, as is normal refinery practice, sweet green crude was charged to one crude still and sour black crude was charged to the other still. The usual complement of gasoline, naphtha and distillates were produced from each unit. In addition to these products, the crudes were reduced to 130 to 140 soft point asphalt.

TABLE 1
Ultimate Yields Including Catalytic Polymerization

	BPD	Volume Percent Fresh Feed	Pounds Per Hour	Weight Percent Fresh Feed
10.5lb Rvp. 400-EP. Gasoline*	2,331	68.72	24,840	56.06
Excess Butanes	232	6.83	1,920	4.33
400-500 Cracked Distillate	395	11.64	5,115	11.54
Synthetic Bottoms	421	12.41	6,115	13.80
C_4 and Heavier Liquid Recovery	3,379	99.60		
Propane and Lighter			2,988	6.74
Carbon			3,336	7.53
Total			44,314	100.00

* 10.5 Rvp. is weighted annual average for Casper Refinery.
** To fuel oil, cutback in road oils (would be thermally cracked in larger plant).

TABLE 2
TCC Component Yields

	BPD	Volume Percent Fresh Feed	Pounds Per Hour	Weight Percent Fresh Feed
Debutanizer 400-EP. Gasoline	1,947	57.5	20,825	47.0
Butanes	547	16.1	4,662	10.5
400-500 Cracked Distillate	395	11.6	5,115	11.5
Synthetic Bottoms	421	12.4	6,115	13.9
C_4 and Heavier Liquid Recovery	3,310	97.6		
Propane and Lighter			4,261	9.5
Carbon			3,336	7.5
Total			44,314	100.0

TABLE 3
Consolidated Refinery Yields

CRUDE STILLS:	Sample Ident.	Barrels Per Day	Percent Total Crude
Straight-Run Gasoline	G & D	1,091	
Straight-Run Naphtha	J & Q	259	
Kerosine	P	560	
No. 1 Heating Fuel	N	163	
Diesel Fuel	I	159	
Cracking Charge Stock:			
Gas Oil	E, L, H, M, S, P	3,161	
Distillate	HH	231	
Asphalt	K & R	705	
Gas and Loss	C & D	111	
Crude Charge	A & B	6,440	
TCC, Vapor Recovery* and Cat. Poly.:			
Butane	BB	83	
Cat. Poly. Gasoline; 21.8 Rvp.	AA	349	
TCC Gasoline; Debut. 400 EP	X & Z	1,938	
Cat. 400/500 Dist.	Y	395	
Synthetic Bottoms	W	421	
Gas & Loss, Lbs./Hr.	CC & U	5,528	
Carbon, Lbs./Hr.		3,336	
Total Distillation:			
Butane		83	1.29
Straight-Run Gasoline		1,091	16.94
Cat. Poly. Gasoline		349	5.42
TCC Gasoline		1,938	30.09
Total Gasoline		3,461	53.74[a]
Straight Run Naphtha		259	4.01
Kerosine		560	8.69
No. 1. Heating Fuel		163	2.54
Catalytic 400/500 Dist.		395	6.13
Diesel Fuel		159	2.46
Synthetic Bottoms		421	6.54
Asphalt		705	10.95[b]
Total Liquid Product		6,123	95.06
Gas & Loss, Lbs./Hr.		5,528	
Carbon, Lbs./Hr.		3,336	

* Includes Crude Still Gas.
[a] 53.15 was average over first half of year 1950.
[b] 9.5 was average over first half of year, 1950.

TABLE 4
Product Inspections

Flow Sheet Symbol		SWEET CRUDE PRODUCTS							SOUR CRUDE PRODUCTS						TCC PRODUCTS							BLENDED GASOLINES	
	(A)	(G)	(J)	(P)	(L)	(K)	(C)	(B)	(Q)	(N)	(R)	(D)	(Z)	(X)	(Y)	(W)	(AA)	(BB)	(CC)	(D)		
Product	Sweet Crude 3,990	200 E.P. Gasoline 533	300 400 Naphtha 72	400 500 Kerosine Distillate 560	500 600 Diesel 159	140 SP Asphalt 212	Off Gas 3,589 scfh	Sour Crude 3,356	300 400 Naphtha 278	400 500 Distillate 383	140 SP Asphalt 493	Off Gas 2,420 scfh	Debutanizer Bottoms 1,787	350 400 Naphtha 231	400 500 Distillate 395	Synthetic Tower Bottoms 421	Cat. Poly. Gasoline 349	Butane Side Stream 83	CC Debutanizer Charge Accumulator Off Gas 33,730 scfh	Depropanizer Off Gas 29,648 scfh	TCC Gasoline 400 E.P. 10.5lb Rvp	TCC 3 Cat. Poly. Gasoline 400 E.P. 10.5lb Rvp
Quantity, B/D	33.3	63.3	45.7	41.6	36.9	6.8	2,215	28.1	46.0	40.3	4.0	2,256	63.7	34.8	28.3	10.4	74.0	100.0	1,6383	1,5389	61.9	62.2
	.8478	.7264	.7852	.8174	.8401	1.025	(Air=1)	.8566	.7972	.8206	1.0445	(Air=1)	.7249	.8534	.8853	.8972	.8566	.6112	(Air=1)	(Air=1)	.7316	73.05
Type Dist. Percent Rec.	ASTM	ASTM	ASTM	ASTM	ASTM			ASTM	ASTM	ASTM			ASTM	ASTM	ASTM	Vac.Engr.					ASTM	ASTM
IBP	110	200	300	400	500			114	300	400			95	330	400	415					53	92
10 Percent	150	237	317	437	517			162	330	392			121	346	407	460					115	119
20 Percent	186	272	332	458	537			194	335	407			133	354	414	627					133	142
30 Percent	197	322	322	410	549			198	345	416			144	367	415	666					151	162
40 Percent	210	333	333	430	550			213	348	424			164	394	433	705					174	187
50 Percent	223	346	326	440	554			226	353	430			185	394	429	735					202	212
60 Percent	234	358	328	453	560			238	355	437			207	397	433	757					232	243
70 Percent	246	372	332	470	567			252	365	443			235	412	439	795					274	277
80 Percent	262	386	336	492	575			296	374	450			266	429	446	838					306	315
90 Percent	279	404	346	516	587			292	392	463			296	392	459	Cracking					330	351
E.P.	324	434	358	626	626			335	430	495			354	430	492						404	406
Percent Rec.	97	98	97	98	98			99	98	99			99	99	99						98	97
Aniline No. °F		140	155.5	176	176				130.5	146.5			99.0	62.5	77.5	130.5						
Sulfur Weight Percent		0165	0138	027	07		Nil		052	0.048		652	042	206	741	1.79	029	026			052	059
Flash Point °F									096													
Viscosity @ 100										31.5												
Centistokes Carbon						138					131											
Soft Point					183 PM																	
Flash																						
Reid Vap. Press	6.1								4.3				7.5	138 TC	174 TC		21.8	65.5			10.3	10.3
Octane No.																						
Research Clear	56.2								84.1												89.5	90.5
Research 1cc	73.7								93.5												95.0	95.4
Research 2cc	83.3								99.5												96.4	96.9
Research 3cc	88.4								71.6												97.2	97.9

*Cannon Engler corrected to 760 mm.

Catalyst Distribution and Liquid Feed, TCC Reactor, Casper, Wyo.

In this manner, the total gas oil ranging between heating fuel or Diesel distillate and penetration asphalt is produced as a combined fresh feed to the TCC unit. Substantially all of this gas oil is transferred hot to the TCC unit, with only a minimum quantity working through a storage tank for process co-ordination.

At the TCC unit, the virgin gas oil is accumulated in a feed drum together with the TCC recycle stock. This combined feed is heated through a conventional pipe still and flashed in a vaporization drum or tar separator. The vapors from the tar separator pass through a vapor reheat coil of the furnace and into the TCC reactor. The unvaporized liquid from the tar separator is pumped directly into the TCC reactor through a distributing nozzle. Both the liquid and vapors combine to flow through the moving catalyst bed in the reactor.

The reactor effluent is further processed in conventional distillation equipment and vapor recovery plant. The unsaturated light hydrocarbons (propylenes and butylenes) are further processed in a catalytic polymerization unit. The flow diagrams of these units are shown in Figures 1 and 2.

Using the measured quantities and laboratory analyses of the various charge stocks and product streams which prevailed throughout this check run, individual and consolidated yield summaries have been developed. The ultimate yields of standard products for the TCC unit including catalytic polymerization are shown in Table 1. Table 2 presents the TCC yields in terms of certain defined components. Table 3 presents the consolidated yields for the entire operation, including crude oil distillation, catalytic cracking, vapor recovery and catalytic

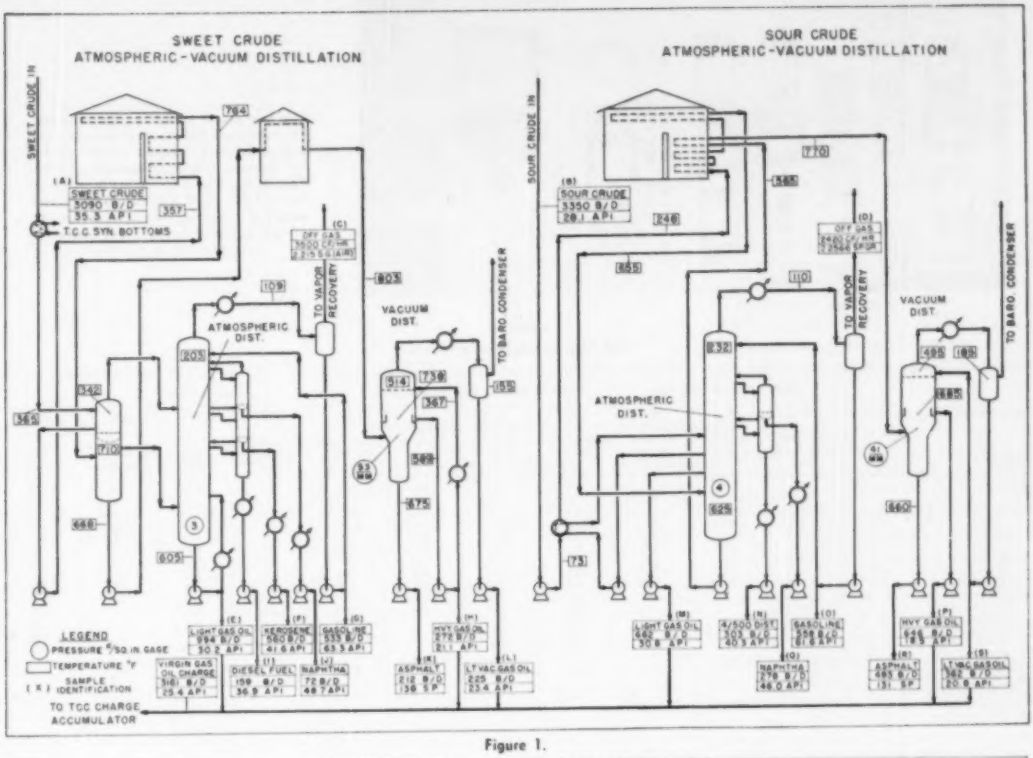

SWEET CRUDE
ATMOSPHERIC - VACUUM DISTILLATION
SOUR CRUDE
ATMOSPHERIC - VACUUM DISTILLATION
SWEET CRUDE IN
SOUR CRUDE IN
SWEET CRUDE
3090 B/D
35.3 API
T.C.C. SYN. BOTTOMS
SOUR CRUDE
5350 B/D
28.1 API
TO VAPOR RECOVERY
TO BARO CONDENSER
ATMOSPHERIC DIST.
VACUUM DIST.
LEGEND
PRESSURE #/SQ. IN. GAGE
TEMPERATURE °F
SAMPLE (X) IDENTIFICATION
TO TCC CHARGE ACCUMULATOR
LIGHT GAS OIL 994 B/D 30.2 API
KEROSENE 560 B/D 41.6 API
GASOLINE 535 B/D 63.5 API
VIRGIN GAS OIL CHARGE 516 B/D 25.4 API
DIESEL FUEL 159 B/D 36.9 API
NAPHTHA 728 B/D 48.7 API
ASPHALT 218 B/D 138 SP
LT VAC GAS OIL 225 B/D 23.4 API
HVY GAS OIL 272 B/D 21.1 API
LIGHT GAS OIL 440 B/D 30.8 API
4/500 DIST. 503 B/D 40.5 API
GASOLINE 258 B/D 67.6 API
NAPHTHA 276 B/D 48.0 API
ASPHALT 685 B/D 131 SP
HVY GAS OIL 646 B/D 18.5 API
LTVAC GAS OIL 562 B/D 20.8 API

Figure 1.

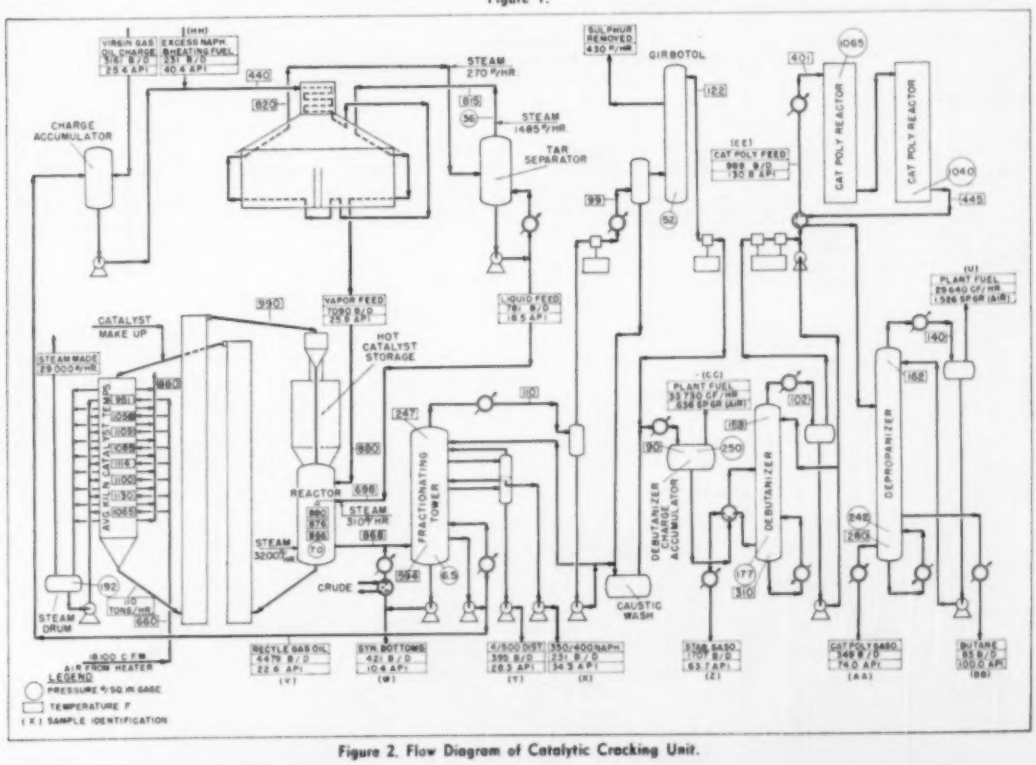
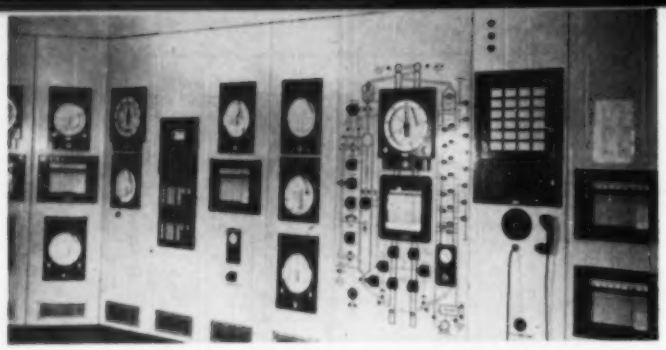

VIRGIN GAS OIL CHARGE 516 B/D 29.4 API
EXCESS NAPH. & HEATING FUEL 237 B/D 40.4 API
STEAM 270 #/HR.
STEAM 1485 #/HR.
CHARGE ACCUMULATOR
TAR SEPARATOR
SULPHUR REMOVED 430 #/HR
GIRBOTOL
CAT POLY FEED 980 B/D 50.8 API
CAT POLY REACTOR
CAT POLY REACTOR
PLANT FUEL 29640 CF/HR 1.526 SP GR (AIR)
CATALYST MAKE UP
HOT CATALYST STORAGE
VAPOR FEED 7090 B/D 29.2 API
LIQUID FEED 78 B/D 10.5 API
STEAM MADE 29000 #/HR
REACTOR
STEAM 3107 #/HR
STEAM 3200 #/HR
FRACTIONATING TOWER
CRUDE
STEAM DRUM
10 TONS/HR
6100 C.F.M. AIR FROM HEATER
DEBUTANIZER CHARGE ACCUMULATOR
DEBUTANIZER
DEPROPANIZER
CAUSTIC WASH
PLANT FUEL 33730 CF/HR .834 SP GR (AIR)
RECYCLE GAS OIL 4478 B/D 22.6 API
SYN. BOTTOMS 421 B/D 10.4 API
4/500 DIST. 389 B/D 29.3 API
350/400 NAPH. 231 B/D 34.3 API
350 GASO. 1707 B/D 63.7 API
CAT POLY GASO. 549 B/D 74.0 API
BUTANE 55 B/D 100.0 API
LEGEND
PRESSURE #/SQ. IN. GAGE
TEMPERATURE F
(X) SAMPLE IDENTIFICATION

Figure 2. Flow Diagram of Catalytic Cracking Unit.



The instrument board for this Thermofor catalytic cracking unit shows partial utilization of a "graphic panel" system for process plant automatic control. Pilot lights and instruments located on the central panel provide warnings and essential operating information for the critical catalytic reaction and regeneration portions of the plant.

TABLE 5
TCC Charge Stock Inspections

Flow Sheet Symbol	SWEET CRUDE GASOIL (E)	(L)	(H)	SOUR CRUDE GASOIL (M)	(S)	(P)	TCC CHARGE (T)	(HH)	(FF)	(GG)	(V)
PRODUCT	Sweet Crude Bubble Tower Gasoil	Green Crude Vacuum Tower Light Gasoil	Green Crude Vacuum Tower Heavy Gasoil	Sour Crude 500/750 Gasoil	Black Crude Vacuum Tower Light Gasoil	Black Crude Vacuum Tower Heavy Gasoil	Total Charge Including Recycle	Excess Naphtha Charge	Tar Separator Overhead	Tar Separator Bottoms	TCC Recycle Gasoil
Quantity B/D	994	225	272	662	362	646	7875	231	7094	781	4479
API	30.2	23.4	21.1	30.8	20.8	18.5	24.9	40.4	25.9	18.5	22.6
Type Distillation (Percent Rec.)	Vacuum Engler	Vacuum Engler	Vacuum Engler	Vacuum Engler	Vacuum Engler	Vacuum Engler	Vacuum Engler	ASTM	Vacuum Engler	Vacuum Engler	Vacuum Engler
I.B.P.	520	480	660	387	525	465	400	310	425	440	414
10 Percent	605	780	896	516	715	781	500	365	490	605	509
20 Percent	650	815	928	547	746	813	525	384	522	690	525
30 Percent	683	833	952	573	772	831	551	398	539	765	538
40 Percent	712	837†	969	602	793	852	580	412	565	827	550
50 Percent	743		980	627	815	880	611	426	588	871†	565
60 Percent	765			655	857	910	648	440	614		595
70 Percent	792			693	882		690	456	646		626
80 Percent	822			714	892		739	474	692		660
90 Percent	856			750	926		819	504	775		692
End Point								590			
Aniline No., °F.	192.9	204.1	219.2	155.3	161.2	179.0	143.2		148.6	178.5	112.5
Pour Point, °F.											
Sulfur Weight, Percent	.15	.33	.38	1.77	2.96	3.14	1.23	.21	1.2	1.61	1.27
Flash Open Cup, °F	270										
Conradson Carbon							.29		.05	2.94	

Note: Vacuum Engler data corrected to 760 mm. † Cracking.

TABLE 6
Light Hydrocarbon Inspections—Podbielniak Analyses

Flow Sheet Symbol	(C)		(D)		(Z)		(AA)		(BB)		(U)		(CC)		(EE)	
Product	Sweet Crude Off Gas 3500 scfh		Sour Crude Off Gas 2420 scfh		Debutanizer Bottoms 1707 B/D		Cat. Poly. Gaso. 349 B/D		Butane Side Stream 83 B/D		Depropanizer Off Gas 29,640 scfh		Debutanizer Charge Accumulator Off Gas 33,730 scfh		Cat. Poly. Charge 989 B/D	
Quantity	Mol. Percent	Weight Percent	Mol. Percent	Weight Percent	Mol. Percent	Weight Percent	Mol. Percent	Weight Percent	Mol. Percent	Weight Percent	Mol. Percent	Weight Percent	Mol. Percent	Weight Percent	Mol. Percent	Weight Percent
Acid and Fixed Gases	13	.07	6.45	3.45							2.76	.49	37.42	5.54	1.32	.23
Methane	2.57	.64	3.32	.84							9.22	3.35	33.77	29.37	4.74	1.32
Ethylene											3.77	2.40	4.53	6.90	2.34	1.37
Ethane	1.65	.78	3.20	1.50							14.31	9.75	7.25	11.83	6.89	4.08
Total											18.08	12.15	11.78	18.73	9.23	5.45
Propylene									.03	.02	2.80	2.88	5.87	13.42	19.48	17.11
Propane	17.21	11.87	11.84	8.18					.82	.54	22.79	22.76	4.10	9.81	11.89	10.93
Total									.85	.56	25.59	25.44	9.97	23.23	31.37	28.04
Iso Butane	8.05	7.32	7.62	6.95			17.46	10.83	35.07	30.65	26.45	34.77	3.01	9.49	22.48	27.26
Iso Butene and 1-Butene							.42	.25	1.00	.85	1.46	1.85	.45	1.39	7.63	8.95
Normal Butane	28.62	26.02	18.05	16.46	.17	.11	11.50	7.16	27.42	24.03	11.56	15.19	1.51	4.77	9.68	11.75
2-Butene					.14	.08	4.07	2.45	9.03	7.67	3.30	4.18	.80	2.45	10.26	12.08
Total	36.67	33.34	25.67	23.41	.31	.19	33.45	20.69	72.52	63.20	42.77	55.99	5.77	18.10	50.05	60.04
Iso Pentane	12.53	14.14	19.84	22.47	18.39	13.87	6.73	5.18	10.93	11.88			.97	3.80	2.16	3.24
Iso Pentene					3.20	2.34	.62	.46	.77	.82			.32	1.23	.66	.96
Normal Pentane	13.49	15.22	12.28	13.89	3.72	2.82	.39	.30	.66	.72					.48	.72
Normal Pentene					6.51	4.77	.59	.44	.76	.80						
Total	26.02	29.36	32.12	36.36	31.82	23.80	8.33	6.38	13.12	14.22	C5+ 1.58	C5+ 2.58	1.29	5.03	3.30	4.92
Hexane Plus Residue	15.75	23.94	17.40	26.26	67.87	76.01	58.22	72.93	13.51	22.02						
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Hexane Plus Residue Data:																
Mol. Wt.	97		98		107		117		108		Sp. Gr. of C5+		Sp. Gr. of Total Gas		°API of Total Charge	
°API	67.1		70.8		56.0		60.9		64.4		=1.5259		=.6363		=130.8	
RVP	4.5		2.8		2.8		1.9		2.3							
Dist.																
IBP	158				158		185		190							
10 Percent	163				176		203		194							
50 Percent	176				228		240		209							
90 Percent	229				317		353		302							
E. P.	273				341		392		320							

TABLE 7
Volume Material Balance

			B/D	Vol. %		FINAL PRODUCT B/D	FINAL PRODUCT Vol. % on Total Crude
3,090 B/D 35.3 API	Sweet Crude Atmos. and Vacuum Dist.	Off Gas	63	2.04			
		Gasoline	533	17.25	→Gasoline	533	8.28
		Naphtha	72	2.33	→Naphtha	72	1.11
		Kerosine	560	18.12	→Kerosine	560	8.69
		Diesel Fuel	159	5.15	→Diesel Fuel	159	2.46
		Bubble Twr. G. O.	994	32.17			
		Lt. Vac. G. O.	225	7.28			
		Hvy. Vac. G. O.	272	8.80			
		Asphalt	212	6.86	→Asphalt	212	3.29
			3,090	100.00			
7,350 B/D 28.1 API	Sour Crude Atmos. and Vacuum Dist.	Off Gas	48	1.43			
		Gasoline	558	16.66	→Gasoline	558	8.66
		Naphtha	278	8.30	→Naphtha	187	2.90
		Heating Fuel	303	9.04	→Heating Fuel	163	2.54
		Bubble Twr. G. O.	662	19.76			
		Lt. Vac. G. O.	362	10.81			
		Hvy. Vac. G. O.	646	19.28			
		Asphalt	493	14.72	→Asphalt	493	7.66
			3,350	100.00			
Excess Naphtha & Heating Fuel from Sour Crude 3,161 B/D 25.4 API							
231 B/D 40.4 API. 3,392 B/D 26.4 API	T. C. C. Catalytic Cracking	C_2 & Lighter					
		C_3	202	5.96			
		C_3	121	3.57			
		IC_4	265	7.81			
		NC_4	92	2.71			
		IC_4= & C_4=1	81	2.39			
		C_4=2	109	3.21			
		IC_5= & NC_5=	146	4.30			
		IC_5 & NC_5	333	9.82			
		C_6—350 B. P.	1,237	36.47			
		350-400 B. P.	231	6.81			
		400-500 B. P.	395	11.65	→400-500 B. P.	395	6.13
		Syn. Bottoms	421	12.41	→Syn. Bottoms	421	6.54
		Carbon					
			3,633	107.11			
2,817 B/D	Vapor Recovery and Cat. Poly. Unit	Fuel Gas					
		Butane	83			83	1.29
		Poly. Gasoline	349			349	5.42
		350 E. P. Gaso.	1,707			1,938	30.09
		350-400 Naphtha	231				
			2,370				
					Total Liquid Recovery	6,123	95.06

polymerization. Tables 4, 5 and 6 show the laboratory inspections of the various streams throughout the system. A detailed volumetric material balance and weight material balance are shown in Tables 7 and 8, respectively.

Table 9 shows a complete analysis of the TCC reactor effluent and the production of light ends as indicated by this analysis. This is compared with the production of light ends as derived from the yield and composition of final end products. It is believed that the differences in the indicated yields of the different components are well within the limits of experimental error.

Conditions specific to the TCC unit are presented in Tables 10 and 11. Table 10 describes the nature and quantity of the liquid feed as charged to the reactor. Table 11 presents the significant TCC operating conditions which prevailed during the check run.

This check run proved to be quite satisfactory. Exceedingly consistant measurements were realized throughout the system, and the over-all operation and yields check well with the average refinery operation for the past year. The results of this check run are presented here in order to give the most complete set of consistant data for the entire operation.

Note—The final four tables appear on the next page.

This general view of the Casper refinery, photo below, has the TCC unit in the middle background and the crude oil distillation units and power house in the foreground.

TABLE 9
Composition of TCC Reactor Effluent

	ANALYSIS OF REACTOR EFFLUENT			Composition of 350 and Lighter Calculated From End Products
	Total Effluent		350 B.P. and Lighter Ratioed to 100 Percent	
	Volume Percent	Weight Percent	Weight Percent	Weight Percent
Hydrogen Sulfide	.35	.54	2.09	1.64
Other Acid & Fixed Gases	.55	.16	.66	.35
Methane	1.89	.57	2.21	2.14
Ethene	.60	.20	.78	.81
Ethane	1.11	.51	1.97	1.85
Total	1.51	.71	2.75	2.66
Propene	2.21	1.40	5.41	5.73
Propane	1.72	1.07	4.14	3.34
Total	3.93	2.47	9.55	9.07
Iso-Butene	2.84	1.95	7.54	8.13
Iso-Butene and Butene-1	.76	.55	2.13	2.65
Normal Butane	1.46	1.04	4.02	2.92
Butene-2	1.33	1.00	3.87	3.66
Total	6.39	4.54	17.56	17.36
Iso-Pentane	2.64	2.01	7.78	9.85
Iso-Pentene	.80	.63	2.44	1.92
Normal Pentane	.48	.37	1.43	1.56
Normal Pentene	.72	.57	2.21	3.21
Total	4.64	3.58	13.86	16.54
Hexane Plus—200	5.63	4.81	18.59	
200–250	2.93	2.71	10.47	50.24
250–300	2.86	2.80	10.82	
300–350	2.94	2.96	11.44	
Total	14.36	13.28	51.32	50.24
350–400	3.23	3.34	.....	.....
400–450	3.34	3.55	.....	.....
450–500	10.50	11.52	.....	.....
500–515	4.41	4.97	.....	.....
515–701	37.62	42.22	.....	.....
Residue	6.98	8.55	.....	.....
	66.08	74.15	.....	.....
TOTAL	100.00	100.00	100.00	100.00
Quantity Lbs. per Hour	.....	100,767	26,059	26,865

TABLE 10
Liquid Charge to TCC Reactor

Liquid Charge, B/D	781
Liquid Charge, Lbs./Hr.	10,737
Volume Percent Based On:	
Fresh Feed to Unit	23.2
Total Feed to Reactor	9.9*
Laboratory Inspection:	
°API	18.5

VACUUM ENGLER DISTILLATION†

IBP	440 °F.
10	605 °F.
20	690 °F.
30	765 °F.
40	827 °F.
50	871 °F.
60	Cracking
Aniline Number	178.5
Sulfur, Weight Percent	1.61
Conradson Carbon	2.94

* 9-10 usual range. † 760 mm.

TABLE 11
TCC Operating Conditions, June 15, 1950

Space Vel., Total Feed	1.62
Catalyst/Oil Ratio, Volume Percent	
Total Charge	2.90
Catalyst to Reactor, °F.	990
Avg. Catalyst Temperature in Reactor, °F.	875
Vapor Feed to Reactor, °F.	860
Liquid Feed to Reactor, °F.	698
Catalyst Activity	29.9
Recycle Ratio by Volume	1.32 to 1
Gravity of Fresh Feed, °API	27.8
Vol. Percent Liq. Feed in Total Reactor Charge	9.9
Vol. Percent Liq. Feed Based on Fresh Feed	23.2
Steam, Weight Percent Total Feed	2.2
Reactor Top Pressure, psig	9.5
Catalyst Circ., T./Hr.	110
Carbon on Spent Catalyst, Weight Percent	1.90
Carbon on Reg. Catalyst, Weight Percent	.47
Kiln Steam Prod., Lbs. Hr. (Net)	29,000
Lbs. Sulphur Removed in Girbotol, Lbs./Hr.	430

TABLE 8
Weight Material Balance

		Lbs./Hr.	Wt. %		FINAL PRODUCT Lbs./Hr.	Wt. % on Total Crude
38,192 Lbs./Hr. — Sweet Crude Atmos. and Vacuum Dist.	Off Gas	590	1.55			
	Gasoline	5,647	14.79	→ Gasoline	5,647	6.96
	Naphtha	824	2.15	→ Naphtha	824	1.02
	Kerosine	6,674	17.47	→ Kerosine	6,674	8.23
	Diesel Fuel	1,946	5.10	→ Diesel Fuel	1,946	2.40
	Bubble Twr. G. O.	12,677	33.19			
	Lt. Vac. G. O.	2,998	7.85			
	Hvy. Vac. G. O.	3,675	9.62			
	Asphalt	3,161	8.28	→ Asphalt	3,161	3.90
		38,192	100.00			
42,923 Lbs./Hr. — Sour Crude Atmos. and Vacuum Dist.	Off Gas	396	.92			
	Gasoline	5,954	13.87	→ Gasoline	5,954	7.34
	Naphtha	3,232	7.53	→ Naphtha	2,124	2.62
	Heating Fuel	3,635	8.47	→ Heating Fuel	1,974	2.43
	Bubble Twr. G. O.	8,413	19.60			
	Lt. Vac. G. O.	4,905	11.43			
	Hvy. Vac. G. O.	8,877	20.68			
	Asphalt	7,311	17.50	→ Asphalt	7,311	9.26
		42,923	100.00			
Excess Naphtha and Heating Fuel 41,545 Lbs./Hr.						
2,760 Lbs. Hr. / 44,314 Lbs./Hr. — T. C. C. Catalytic Cracking	C_3 & Lighter	1,826	4.12			
	$C_3^=$	1,537	3.47			
	C_3	898	2.03			
	IC_4	2,182	4.92			
	NC_4	784	1.77			
	$IC_4^=$ & C_4=1	712	1.61			
	C_4=2	984	2.22			
	$IC_5^=$ & $NC_5^=$	1,380	3.12			
	IC_5 & NC_5	3,062	6.91			
	C_6—350 B. P.	13,498	30.46			
	350-400 B. P.	2,883	6.51			
	400-500 B. P.	5,115	11.54	→ 400-500 B. P.	5,115	6.30
	Syn. Bottoms	6,115	13.80	→ Syn. Bottoms	6,115	7.54
	Carbon	3,336	7.52	→ Carbon	3,336	4.11
		44,314	100.00			
30,734 Lbs./Hr. — Vapor Recovery and Cat. Poly. Unit	Fuel Gas	5,528	17.99	→	5,528	6.82
	Butane	740	2.41	→	740	.91
	Poly. Gaso.	3,507	11.41	→	3,507	4.32
	350 E. P. Gaso	18,076	58.81	→	20,959	25.84
	350-400 Naph	2,883	9.38			
		30,734	100.00			
				Total Weight Balance	81,115	100.00

IT HAS BEEN estimated that well over half of the investment for refinery process facilities goes for distillation equipment. The bubble tray, of course, constitutes a fractional but still quite appreciable part of this investment. Literally tens of thousands of them are used in the industry.

In this two-part series the author presents sufficient information on practice, theory, and procedure so that the relatively inexperienced plant process man can design satisfactory trays. Or check the operation of existing trays at plant loads.

Part I, which was published in the August issue, covered the mechanical details of bubble tray selection and evaluation. This concluding Part II treats the actual tray calculations.

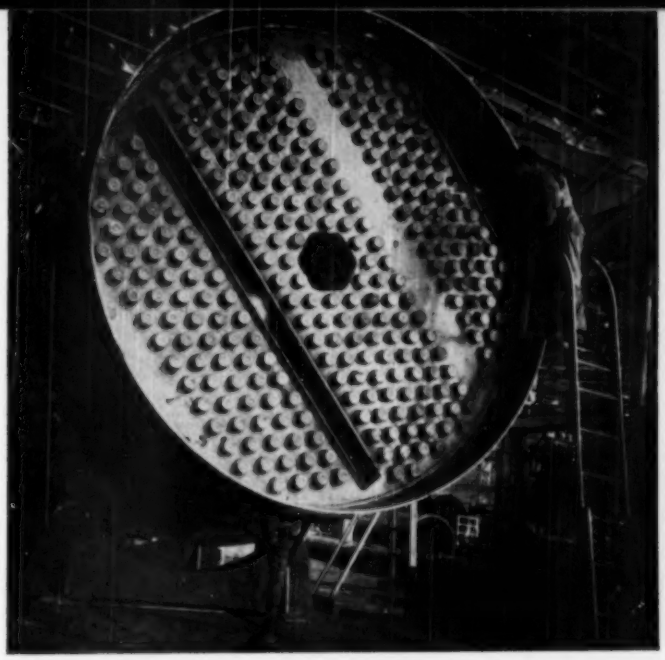


Figure 4. Split Flow, Showing a Three-Pass Tray. Tray diameter 12½ feet. Cap diameter, 4½ inches. Courtesy C. F. Braun & Company.

BUBBLE TRAYS---
Design and Layout

PART II

JAMES A. DAVIES
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Tray Items Fixed Before Making Layout

IN THE discussion of bubble tray layout design it will be assumed that the tray spacing, tower diameter and cap design have been fixed previously, and the problem at hand is to lay out the tray in such a manner as to meet best the anticipated load conditions. The tower diameter and tray spacing are normally based on a correlation of allowable vapor velocity developed from a consideration of Stoke's Law. There are numerous references to the effect entrainment has on tray efficiency,[5,15,18] and to allowable vapor velocities in the literature.[10,11,15,17,19] In some cases, such as strippers and absorbers, the allowable vapor velocity is reduced because entrainment of heavy ends cannot be tolerated or because of fear of foaming the liquid.[2,18] Based on petroleum refining experience the tray spacing should never be lower than 18 inches and 20 or 24 inches are frequently set up as the minimum. Below 18 inches entrainment increases rapidly with a decrease in the spacing. Except for these minimum values the tray spacings used are based on consideration of accessibility and mechanical design as previously discussed. Economic studies have shown that the smallest tray spacing that can practically be used is generally the preferable spacing. It occurs sometimes that the tray spacing or tower diameter has to be increased as calculations may show that priming conditions would occur with the initial choice. With properly designed trays, however, the tower diameter based solely on vapor load will be sufficient to handle the required liquid load except in rare cases.

The cap design is usually based on the whims and past practice of the designer. There has been some progress made in learning the effect of cap and riser design on the tray efficiency.[6,10] However, a standard cap is normally used and no check is made to find out whether a different design would better fit the particular design conditions. This is not as serious as it may seem as it frequently happens that the operating conditions may change considerably during the life of the tray, and these new conditions would require yet a different cap design. When round bubble caps are used they are frequently of 6-inch diameter with 4-inch risers, or 4-inch with 3-inch risers. Caps 3 inches in diameter with 2-inch risers have been frequently used for vacuum tower service and caps as large as 8 inches have been successfully used in various services. For a given total riser area the larger the cap diameter the cheaper the caps will be. However, large caps cannot be fitted into small diameter trays without leaving large spaces for possible liquid by-passing and high pressure drop will be experienced.

Other items that are chosen before the tray layout is made are as follows:

1) *Static Submergence*

This is the depth of liquid standing over the top of the slots when no liquid is flowing over the weir. There is some evidence to support the view that the deeper this is the greater will be the tray efficiency.[10,15] However, if the

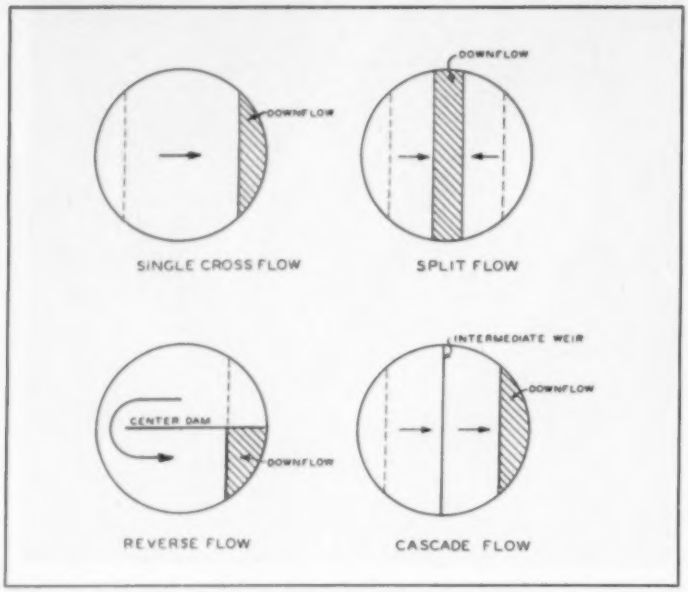


Figure 5. Flow Patterns for Different Types of Trays.

static submergence becomes too large, the efficiency will be adversely effected, as follows:

a) Effective tray spacing is decreased with resulting increase in entrainment.

b) Free height in downflow is decreased which increases the possibility of priming the tower.

c) Increase in tray pressure drop. This will increase the bottom tower pressure and decrease the alpha's or relative volatilities of the material being fractionated.

Table 5 shows the frequently used static submergence for satisfactory operation.

It has been observed that when caps are located too close to the overflow weir the vapor issuing from the caps tends to blow the liquid over the weir and thereby decrease the static submergence.[12] To avoid this trouble it is suggested that 3 inches be provided between the weir and the slots of the nearest cap.

2) *Cap Skirt Height*

Some designers like to keep the skirt height as small as possible with the idea that there will be less space below the cap for liquid to by-pass possible contact with vapor. This arrangement allows the vapor to sweep the tray surface thereby lessening the chance of a build up of sediment. Other designers accept the fact that sediment will build up on the tray surface and will eventually plug up some of the slot area, so they keep the skirt height large. There are no data available proving that a large skirt height decreases the fractionation efficiency by allowing liquid to by-pass the slots. See Table 5 for recommended skirt heights for various services found in petroleum refining. In some cases where a large liquid load is present, caps are sometimes raised to decrease the liquid gradient.

TABLE 5
Recommended Setting for Cap Skirt Clearance, Downflow Seal, and Static Submergence

Cap Skirt Clearance

Service	Setting	Example
Clean	½"	Naphtha Fractionation, Depropanization
Normal	1"	Crude Distillation
Dirty	1½"	Distillation of a liquid that is apt to carry material that will deposit on tray.

Downflow Seal

Tray Diameter	Setting
4'-0"	½"
6'-0"	¾"
8'-0"	1"
10'-0"	1"
12'-0"	1"
16'-0"	1¼"
20'-0"	1½"
24'-0"	1½"

Static Submergence

Tower Operating Pressure	Setting
Vacuum (30 mm. Hg abs.)	0"
Atmospheric	½"
100 psig	1"
300 psig	1½"
500 psig	1½"

3) *Downflow Seal*

In order to insure vapor flowing through the risers and not up the downflows the bottom of the downflow must be below the level of the liquid on the tray. The distance the bottom of the downflow is below the liquid level when no liquid is flowing is called the "seal." Since the tray will not be level as previously discussed, the seal, based on a level tray, must be great enough to insure a real seal in the actual tray. See Table 5 for seals that are used for various sizes and types of trays. This table is based on a type of tray that is not provided with an inlet weir. If an inlet weir is provided, smaller seals may be used since the weir is located close to the downflow.

Inlet weirs are used sometimes to shield the opening below the bottom of the downflow from the vapors issuing from the caps adjacent to the downflow. Inlet pots are also resorted to for the same reason. The construction where the floor of the tray below the downflow is sunken so that the bottom of the downflow can be located below the bottom of the cap slots is called a pot. Inlet weirs reduce the free space in the downflow and the tray will tend to prime at a smaller load than a tray without an inlet weir. The use of an inlet pot or an inlet weir will result in a section of the tray that is liable to fill up with sediment. These sections should be avoided when heavy sedimentation or coking is expected.

The downflow baffles should be located a sufficient distance from the nearest row of caps in order to avoid the possibility of vapors passing up the downflow where neither inlet weirs nor inlet pots are used. If a 5-inch distance is kept between the downflow baffle and the nearest cap slot, no vapor should enter the downflow.

Items That Affect Efficiency

Items considered as affecting the over-all efficiency of the tray to be designed follow:

1) *Vapor-Liquid Contact*

The function of the cap and the slots is to break up the vapor into small bubbles to obtain good contact of the vapor with the liquid. Since in fractionation, the gas film is frequently controlling, it is important to obtain a good break up of the vapor into small bubbles to pass through the liquid. The slots of the cap are designed so as to obtain a satisfactory break up of vapor. For this reason sufficient slot area should be provided so that under maximum vapor loading the vapor does not bubble underneath

the slots. Also, locating the caps too close together will cause the bubbles issuing from separate caps to coalesce, thereby defeating the purpose of the slots. The little information contained in the literature indicates that the greatest horizontal distance from the slots that the bubbles reach is not over 1 inch.[10] Hence, the minimum spacing of the caps should be that which gives 1½ inches clear distance between them.

Too high a slot velocity will cause the vapors to cone or "blow" and not contact the liquid. Too low a slot velocity will cause pulsations resulting in poor contact with the liquid. Refer to equations (9), (10) and (22).

2) *Liquid Distribution*

Maximum tray efficiency cannot be secured unless the liquid is evenly distributed over the entire tray surface so that maximum contact with the vapors can be achieved. This is mainly achieved by providing long segmental weirs that are more than 75 percent as wide as the widest part of the tray and providing notches in the weirs to maintain a ¼-inch head over the weir at low liquid loads.

3) *Vapor Distribution*

The vapor should be evenly distributed through all the risers and slots in order to get the maximum contact of vapor and liquid. If the liquid gradient is large, a large proportion of the vapor will pass through the risers adjacent to the overflow weir, cross over to the other side of the tray countercurrent to the flow of liquid and then go through the risers adjacent to the overflow weir on the tray above.[7] This crossing over of the vapors countercurrent to the flow of liquid can cause an appreciable increase in the liquid gradient, especially if there are cross beams supporting the tray above that restrict this cross flow of vapor. It is recommended that the major beams be located normal to the flow of liquid. Refer to equation (19) for the vapor distribution ratio.

The caps should be evenly distributed over the tray, but should not be located with a clearance of more than 1½ inches from the shell so that liquid passing around the shell will be swept with bubbles.

4) *Cross Flow of Liquid*

It has been frequently pointed out that if a liquid concentration gradient is attained across a tray, the over-all tray efficiency will be higher than that experienced where the liquid on the tray is completely mixed.[10,12] Thus, a cross flow tray would generally be preferable to a split flow tray or one with circular downflows distributed over the whole tray. The reverse flow tray would be preferable especially, if the inlet of one tray is directly above that of the tray below, to the cross flow tray. However, the more rows of caps there are per pass of a split flow tray, the more nearly the split flow tray will behave like the single cross flow tray. A greater number of rows than five or six rows of caps per liquid pass does not appreciably increase the over-all efficiency.

5) *Pressure Drop*

Since the relative volatility is generally decreased by an increase in pressure, it will take more trays to give a certain separation when operating under a high pressure drop than when operating under the same conditions under a low drop. A high-pressure drop is also objectionable because it raises the bottom temperature thereby increasing the required reboiler surface, increasing the chance of unwanted chemical reactions and increasing the corrosion rate experienced in the bottom of the tower. See equation (15).

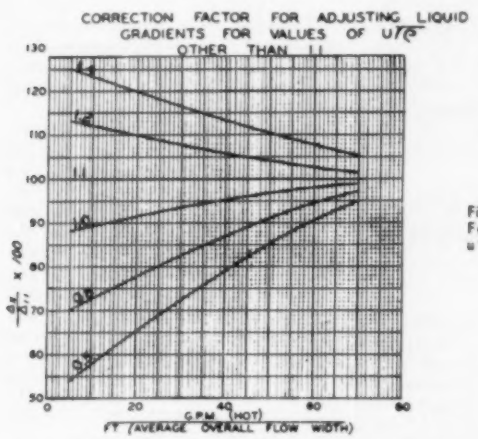
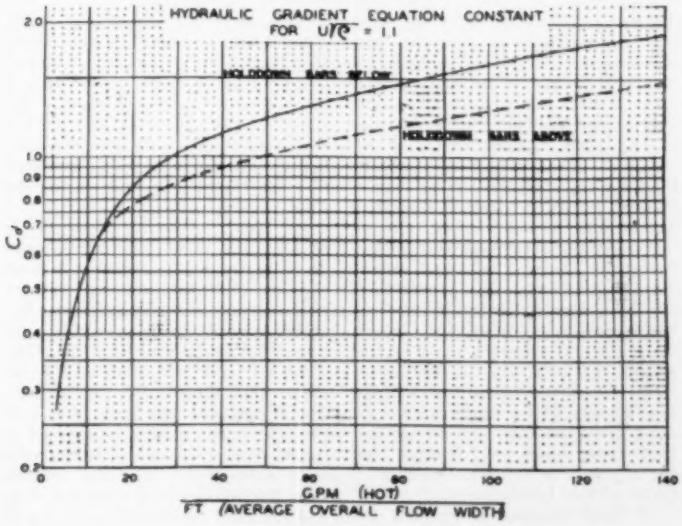


Figure 6. Liquid Gradient Factor Correlation (at $u\sqrt{\rho_v} = 1.1$) and Correction Factor.



Tray Features

In the layout of bubble trays, the foregoing items that are assumed to affect the tray efficiency are incorporated into the design in such ways as to give a tray three features.[4] These are as follow:

1) *Balance*

Balance is the ability to maintain satisfactory efficiency under flowing conditions when operating with design loads of vapor and liquid.

The tray spacing, tower diameter, and cap design are mainly determined

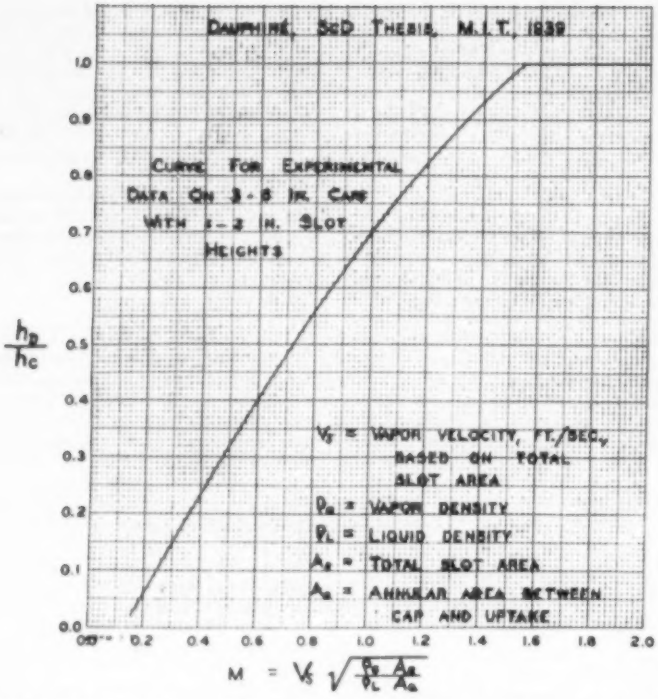

DAUPHINÉ, 3RD THESIS, M.I.T., 1939
CURVE FOR EXPERIMENTAL DATA ON 3-8 IN. CAPS WITH 1-2 IN. SLOT HEIGHTS
$\frac{h_2}{h_c}$
V_s = VAPOR VELOCITY, FT./SEC., BASED ON TOTAL SLOT AREA
D_g = VAPOR DENSITY
D_L = LIQUID DENSITY
A_s = TOTAL SLOT AREA
A_a = ANNULAR AREA BETWEEN CAP AND UPTAKE
$M = V_s \sqrt{\frac{D_g}{D_L}\frac{A_s}{A_a}}$

Figure 7. Pressure Drop Through Bubble Caps. (Plot of ratio of pressure drop through dry cap to that for liquid on the tray up to the top of the slots.)

from design vapor flow rates. The flow of liquid across the tray has a profound influence on the over-all efficiency for many reasons in addition to the liquid concentration gradient and is one of the major factors that determine the layout.

2) *Flexibility*

Flexibility is the ability to maintain satisfactory efficiency under conditions where either vapor or liquid rates are greater or less than design rates.

At high vapor velocities in excess of maximum vapor design rates, the increase in entrainment and decrease in local efficiency due to insufficient contact (vapors jetting from the slots) will adversely affect the over-all efficiency. At very low vapor loads poor vapor-liquid contact is attained as a result of vapor being poorly distributed over the tray—that is, channeling; also the vapor flow will pulsate which adversely affects the local and over-all efficiencies.

3) *Stability*

Stability is the ability to maintain satisfactory efficiencies under changing flow or unsteady state conditions.

Fluctuating vapor rates will greatly decrease the over-all efficiency. An acceleration of vapor velocity produces an additional head term in Bernouilli's equation, and similarly a deceleration produces a negative head term. An accelerating vapor rate in a bubble tower, if great enough even though of very short duration, will blow the liquid away from the cap; in consequence of the following deceleration of vapor rate, the liquid rushes back to the space it originally occupied around the cap. The momentum of the liquid flowing back and the negative deceleration head present force the liquid up the annular space between the cap and riser. If the variation or surge is sharp enough, liquid will backtrap momentarily through the risers; i.e., liquid will flow down through the risers. This phenomenon can occur even if the maximum absolute vapor velocity attained in the surge does not exceed or even approach the maximum allowable velocity which the tower can handle satisfactorily under steady-rate conditions. A stable tray will absorb all vapor and liquid rate changes that are expected to occur normally in a tower without backtrapping.

Of these features, balance is the most important and the most readily analyzed in the design of a satisfactory tray. Flexibility can be incorporated into tray design by checking the tray balance at vapor and liquid loads greater or less than design loads. Stability is difficult to evaluate because of lack of knowledge of the causes, magnitude of fluctuations experienced, and complex nature of the mathematical analysis describing these effects.

Tray Layout

The type of bubble tray that is considered here has the following characteristics:

1) Caps and risers are round.
2) Caps are on isosceles triangular spacing.
3) Caps are all identical and cap spacings are identical.
4) Tray is level.
5) Rows of caps are normal to flow.
6) Tray is cross-flow type.
7) No inlet weir.

Crossflow trays are recommended because of the possible increase of efficiency due to the liquid concentration gradient existing. It also lends itself easily to proper downflow design.

In the design of a bubble tray a tentative layout is first made and then the tray is checked for balance, flexibility and stability. The layout is then revised to improve these three features.

In making the tentative layout the initially fixed items and the various foregoing suggestions should be followed as far as possible. In general, equilateral triangular cap spacing will prove to be the most desirable layout arrangement. Experience will facilitate the making of an acceptable tentative layout. The final layout must meet the tests of balance, flexibility and stability. These tests are as follows:

A. *Balance*

1) Bubble cap slots run nearly wide open but without the vapor passing under the slots. The slot opening can be checked by various methods.[16] See equations (9), (10) and (22). If the slots are not quite wide open the number of caps provided can be decreased to bring the slot opening to the desired amount.

2) Vapor pressure drop per tray to be low. The allowable tray pressure drop increases with increase in total pressure. For instance, for vacuum tower service operation at 35 mm. Hg. absolute pressure, the allowable pressure drop is frequently 3 mm. Hg. (.058 psi.) per tray, while at 300 psi. the pressure drop is 0.15 psi. per tray. For atmospheric operation, it is 0.10 psi. The pressure drop is assumed to be the sum of the head over the weir, static submergence, and the pressure drop through the risers, caps and slots, and the head produced by the liquid

gradient. See equation (15).

3) Vapor well distributed over the whole tray. The vapor distribution ratio, Δ/h_g, is a measure of how well the vapor is distributed between all caps. It should always be less than 0.60 and normally is less than 0.40. A mathematical study shows that with a vapor distribution ratio of 0.40 for a single crossflow tray, the velocity of the crossflowing vapor above the tray will not be objectionable but a ratio of 0.60 tends to induce an objectionable crossflow. To keep the ratio low the following steps can be made:

I) Decrease Δ, liquid gradient,

a) wider cap spacing.
b) higher skirt height.
c) higher weir.

II) increase h_g, cap and riser pressure drop,

a) decrease number of caps.
b) provide a choke in riser or cap.

Sometimes the vapor distribution ratio cannot be kept low and other steps must be taken. With increasing liquid load the following order of type of tray layout will give a decrease in Δ/h_g:

a) reverse flow tray.
b) reverse flow tray with cascade steps.
c) single pass tray.
d) single pass tray with cascade steps.
e) split flow (Figure 4 shows a three pass tray).
f) split flow with cascade steps.

Figure 5 shows typical liquid flow arrangements for trays in normal service.

In order for the intermediate weirs of the cascades to operate as true weirs and not as submerged weirs, the difference in heights of adjacent weirs must be greater than the head over the downstream weir, plus the liquid gradient between them. Usually this height difference can be kept at 2 inches.

In order to give a uniform vapor distribution over the whole tray the same liquid gradient should be obtaining in each cascade section, and the same flowing submergence at the weir must be attained. Sometimes, also, the skirt clearance of the caps in adjacent rows is increased or "pitched" by an amount that approximates the liquid gradient in order to improve the vapor distribution. This, of course, maintains a constant flowing submergence on all caps.

4) Sufficient free height in downflow. A tray will prime when the liquid fills the downflow up to the top of the weir. The calculation of the height of the liquid level in the downflow above the tray assumes the liquid contains no entrained vapor. However, the liquid will contain entrained vapor and will stand higher than calculations indicate.[8,18] It is considered good practice to keep the minimum free height (see equation 18) in the downspout equal to at least one-half the tray spacing.

5) Downflow residence time. If the residence time of the downflowing liquid is sufficiently long, most of the entrained vapor will escape. A study of priming towers showed that the maximum residence time of any of the

Figure 8. Typical Layout for a Tray that is to Operate at Pressures close to Atmospheric Pressure.

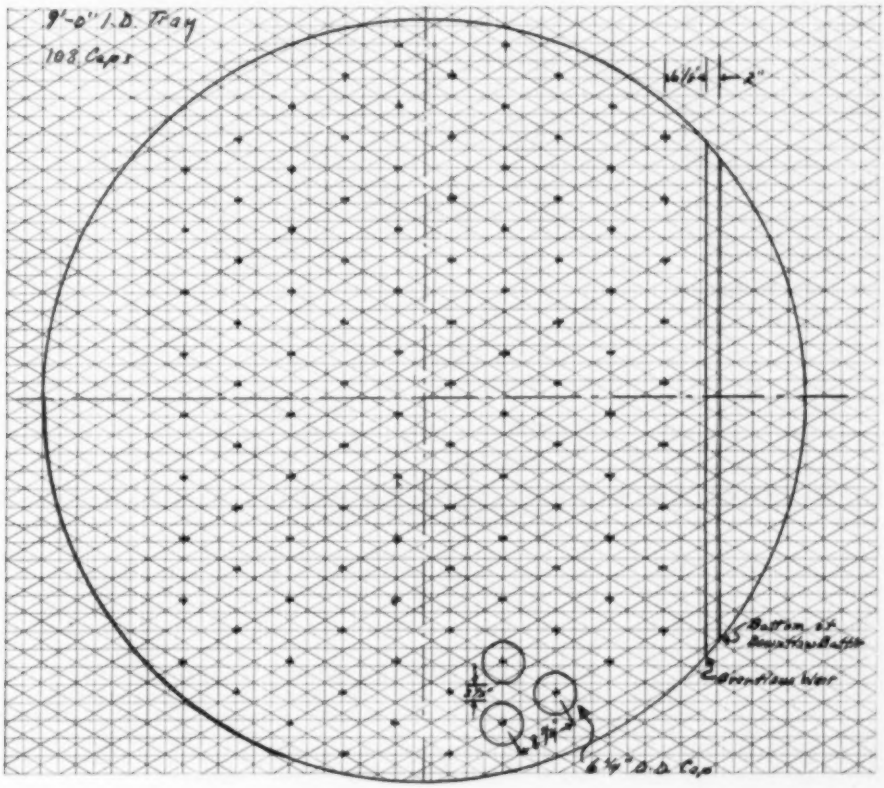


Figure 9. Tower and Tray Capacities, Calculation Sheet. (Shows the tray and cap dimensions and the calculated values for the condition of maximum liquid and vapor loading.)

towers priming was four seconds. It is recommended that a minimum residence time of five seconds be maintained at all times. The residence time is based on the total volume of the downflow based on the average cross sectional area times the tray spacing. The downflow free heights found in these priming towers were about one-third of the tray spacing.

6) Width of downflow. Any downflow should have a width sufficient to allow vapor, disengaged from the liquid in the downflow, to pass out of the downflow past the entering liquid. In the case of two pass trays the width should be twice that for a single pass tray. With crossflow trays it is usually easy to obtain a satisfactory downflow width. See equation (21).

7) Height of liquid over weirs. The head of liquid over the weirs, equations (11), (12), and (13), is kept low in order to keep the tray pressure drop low. Where there are cascade sections with very different weir lengths, the weir heights should be adjusted so as to give the same flowing submergence in each section and, hence, even vapor distribution. This means that the head over the weir plus the static submergence must be equal for each section.

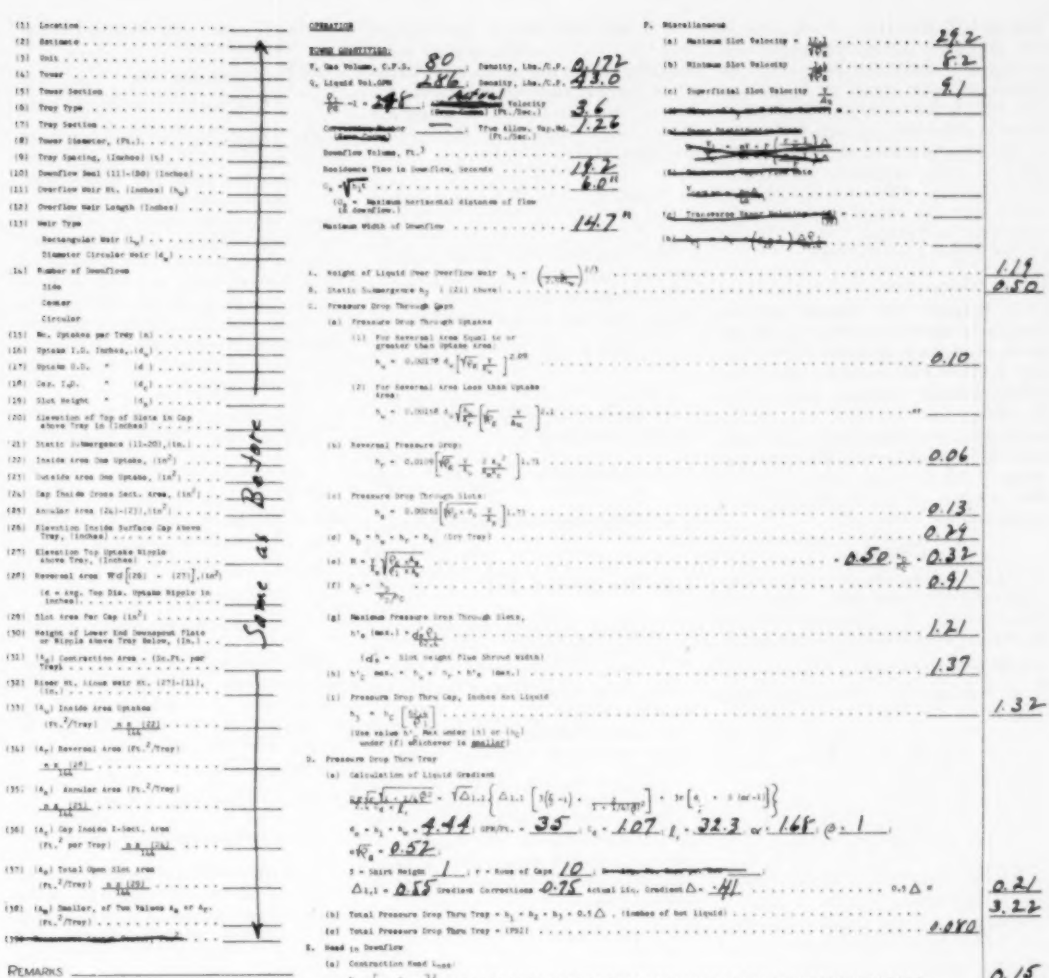

OPERATION
TOWER CAPACITIES:
F, Gas Volume, C.F.S. 80
Density, Lbs./C.F. 0.172
Q, Liquid Vol.GPM 286
Density, Lbs./C.F. 43.0
Velocity (Ft./Sec.) 3.6
Velocity (Ft./Sec.) 1.26
Downflow Volume, Ft.³
Residence Time in Downflow, Seconds 19.2
6.0"
Maximum Horizontal Distance of Flow in Downflow.
Maximum Width of Downflow 147"
P. Miscellaneous
(a) Maximum Slot Velocity = 29.2
(b) Minimum Slot Velocity 6.2
(c) Superficial Slot Velocity 9.1
1. Height of Liquid Over Overflow Weir 1.19
2. Static Submergence h₂ = (21) Above 0.80
3. Pressure Drop Through Caps
(a) Pressure Drop Through Uptakes
(1) For Reversal Area Equal to or greater than Uptake Area: 0.10
(2) For Reversal Area Less than Uptake Area:
(b) Reversal Pressure Drop: 0.06
(c) Pressure Drop Through Slots: 0.13
(d) 0.29
(e) 0.50 × 0.32
(f) 0.91
(g) Maximum Pressure Drop Through Slots, 1.21
(h) 1.37
(i) Pressure Drop Thru Cap, Inches Hot Liquid 1.32
(Use value h'ₒ Max under (h) or (h)ₒ under (f) whichever is greater)
D. Pressure Drop Thru Tray
(a) Calculation of Liquid Gradient
dₑ = h₁ + h₂ = 1.44 GPM/Ft. = 35 ℓ₁ = 10.7 ℓ₂ = 32.3 or 16.5 @ 1
√dₑ = 0.52
S = Skirt Height 1 r = Rose of Caps 10
Δ1,1 = 0.85 Gradient Corrections 0.75 Actual Liq. Gradient Δ = 1.41 0.5 Δ = 0.21
(b) Total Pressure Drop Thru Tray = h₁ + h₂ + h₃ + 0.5 Δ , (Inches of Hot Liquid) 3.22
(c) Total Pressure Drop Thru Tray = (21) 0.080
E. Head in Downflow
(a) Construction Head 0.15
(b) Liquid Gradient 0.41
(c) Height in Downpost 3.99
D = h₁ + h₂ + h₃ + h₄ + 1.5 Δ
(d) Free Height in Downpost 24.62
F = h − D − h₁
(e) Free Height in Downcomer 0.63
Tray Spacing
(f) Δ/k_g = 0.311
REMARKS

Figure 10. Tower and Tray Capacities, Calculation Sheet. (Shows the case for maximum liquid and minimum vapor loadings for the same tray.)

B) Flexibility

Balance to be checked for the following conditions under which the tray design may be expected to operate either in different locations in a particular bubble tower or under alternative methods of operation of the tower:

a) Maximum vapor rate.
b) Maximum liquid rate.
c) Minimum vapor rate.
d) Minimum liquid rate.
e) High vapor rate with high liquid rate.
f) Low vapor rate with high liquid rate.

Each of these items will influence the final determination of the size or number of various parts of the tray or caps. In respect to item *c*—minimum vapor—it has been noted that at very low vapor rates the vapor does not flow evenly through the caps, but will pulsate. It has been found in practice that when this occurs the efficiency of the tray drops off markedly. A comparison of actual tray efficiencies indicated that pulsation occurs when the superficial slot velocity is lower than $3.4/\sqrt{\rho_g}$. In respect to item d—minimum liquid rate—the weir should be designed so as to give a minimum head of liquid of ¼ inch. The tray may be out of level by ¼

inch and, if the level over the weir is less, very poor liquid distribution will result. The weirs can be notched to give a minimum head of ¼ inch at the lowest liquid rate. The notches should not be over ¼ inch deep so as to give as low a head as possible over the weir with maximum liquid rates. Where a tray will normally operate under very low liquid loads, an inlet weir may be justified to help distribute the liquid over the tray.

C) Stability

1) Maintain the distance between the top of the riser and the top of the slots, m, as large as possible. See Figure 2. This will minimize the possibility of backtrapping of liquid down the riser.

2) Maintain the highest vapor pressure drop permissable. This tends to dampen out the vapor surging so that the number of trays affected by a surge will be minimized.

Equations

Figure 2 shows an elevation of two trays with the terms used to designate various parts. The equations that can be used in tray layouts are now given.

A) Liquid Gradient

a) For caps on triangular pitch centers.[4]

$$\sqrt{\Delta_{t+1}}\,\frac{\ell}{\lambda}\,\Delta_{t+1}\left[3\left(\frac{r}{2}-1\right)+\frac{2}{1+\sqrt{1+\lambda^2\beta^2}}\right]+3r\,[d_c+s\,(\alpha-1)]\,\frac{\ell}{\lambda}=\frac{r\sqrt{r}\,\sqrt{1+\sqrt{1+\lambda^2\beta^2}}}{2.4\,C_4\,l_t}\,Q \qquad (1)$$

b) For caps on equilateral triangular pitch centers.[4]

$$\sqrt{\Delta_{t+1}}\,\frac{\ell}{\lambda}\,\Delta_{t+1}\left(\frac{3r}{2}-1.4\right)+3r\,[d_c+s\,(\alpha-1)]\,\frac{\ell}{\lambda}=\frac{r\sqrt{r}\,Q}{2.15\,C_4\,l_t} \qquad (2)$$

c) For caps on square pitch centers.[4]

$$\sqrt{\Delta_{t+1}}\,\frac{\ell}{\lambda}\,\Delta_{t+1}\left(\frac{3r}{2}-1\right)+3r\,[d_c+s\,(\alpha-1)]\,\frac{\ell}{\lambda}=\frac{r\sqrt{r}\,Q}{2.4\,C_4\,l_t} \qquad (3)$$

C_4, the liquid gradient factor, is obtained from Figure 6. This correlation is for the case where $u\sqrt{\rho_v}=1.1$. For other vapor rates and densities Figure 6 is to be used to correct the liquid gradient, Δ, obtained from equations (1), (2), and (3), in order to obtain the true Δ.

B) Pressure Drop Through Cap and Riser

a) Pressure drop through the riser.[2]

$$h_c=0.00178\,d_c\left(\sqrt{\rho_v}\,\frac{V}{A_c}\right)^{2.09} \qquad (4)$$

Use equation (4) if the reversal area, i.e., the circumference of mean diameter of the top of the riser multiplied by the difference between the top of the riser and the undersurface of the cap, is equal to or greater than the riser area.

$$h_c=0.00158\,d_c\sqrt{\frac{A_c}{A_r}}\left(\sqrt{\rho_v}\,\frac{V}{A_c}\right)^{2.10} \qquad (5)$$

Use equation (5) if the reversal area is less than the riser area.

b) Pressure drop through the reversal area and annular area.[2]

$$h_r=0.0109\left(\sqrt{\rho_v}\,\frac{V}{A_c}\,\frac{2\,A_c^2}{A_m\,A_r}\right)^{1.71} \qquad (6)$$

c) Pressure drop through dry slots running wide open.[2]

$$h_s=0.00261\left(\sqrt{\rho_v}\,d_c\,\frac{V}{A_s}\right)^{1.72} \qquad (7)$$

d) Total dry pressure drop.[2]

$$h_D=h_c+h_r+h_s \qquad (8)$$

e) Wet pressure drop.[2]

$$h_s=\frac{h_D}{\left(\frac{h_D}{h_c}\right)}\times\frac{62.4}{\rho l} \qquad (9)$$

(h_D/h_c is obtained from correlation shown as Figure 7.

f) Check whether caps are bubbling underneath wide open slots.

$$h_{s\,(max)}=(h_c+h_r)\;\;62.4/\rho l+d_s \qquad (10)$$

Use h_s from either equation (9) or (10), whichever is the smaller. If there is a shroud around the cap below the slots, the shroud width must be added to d_s.

C) Total Vapor Pressure Drop Per Tray

g) Head over straight weir.[2]

$$h_l=\left(\frac{Q}{2.98\,l_w}\right)^{\frac{2}{3}} \qquad (11)$$

h) Head over straight notched weir (notches running full)

$$Q=1.19\,\frac{l_w}{h_t}\left[h_l^{\frac{5}{2}}-(h_l-h_t)^{\frac{5}{2}}\right] \qquad (12)$$

i) Head over straight notched weir (notches not running full)

$$Q=1.11\,\frac{l_w}{h_t}\,h_l^{\frac{5}{2}} \qquad (13)$$

Since circular weirs are not recommended as they do not have good vapor disengaging space, no circular weir formula will be given.

d) Static submergence

h_l = difference between the height of the weir (bottom of the notch or straight section when no notches are present) and the height of the top of the slots (14)

e) Total pressure drop

$$h=h_s+h_d+h_l+0.5\,\Delta \qquad (15)$$

The liquid gradient causes more vapor to pass the caps near the weir than near the inlet side of the tray. This maldistribution causes an increase in pressure drop. A mathematical analysis shows that if the liquid gradient per row of caps is assumed equal for all rows and that if h_l is assumed to be a straight line function of vapor rate, the additional pressure drop caused by liquid gradient is equal to 0.5Δ. These assumptions are fair approximations.

D) Liquid Height in Downspout[2]

a) Constriction drop in downflow

$$h_s=(Q/600A_d)^2 \qquad (16)$$

b) Clear liquid height in downflow above height of liquid at overflow weir (assuming no inlet weir)

$$D=h_l+h_2+h_d+h_s+1.5\,\Delta \qquad (17)$$

c) Free height in downspout

$$F=t-h_l-D \qquad (18)$$

The tower will prime if F is zero. However, since these equations assume clear liquid, i.e., liquid having no entrained vapor, the actual D will be larger than the calculated D from equation (17).

E) Vapor Distribution Ratio

$$\text{Vapor distribution ratio}=\Delta/h_l \qquad (19)$$

This ratio only strictly describes the tendency of the rows of caps at the inlet side of a tray to stop bubbling. This condition will occur when the ratio is 2. However, before this occurs the tray will give poor efficiencies and will become upset. An equation of the ratio of vapor going through the row of caps next to the weir to the vapor going through the row next to the downflow can be developed based on the assumptions described for equation (15). It will show that the ratio Δ/h_l is not quite a direct function of the ratio of the two vapor rates. For the usual conditions, if the ratio of the two vapor rates is 1.5, the ratio, Δ/h_l will be approximately 0.40.

Recommended Values

The recommended values that should be used in laying out a tray are given below

a) Liquid Gradient

The liquid gradient should be kept to 0.5 inch, but not over 1 inch. A low gradient enhances the flexibility of the tray. If the slots on the average are

Nomenclature

A_a total annular area per tray between the inside of the caps and the outside of the risers, square feet.
A_c total inside cross sectional area of caps per tray, square feet.
A_d constriction area, taken as the smallest area found in the downflow, usually taken as the flow area between the bottom of the downflow and the tray floor, square feet.
A_m smaller of the areas, A_s or A_r
A_r total reversal area per tray between the inside top of caps and the top of the risers area usually taken as the cylinder between the cap and the riser of diameter equal to the average of the inside and outside diameters of the top of the risers, square feet
A_s total cap slot area per tray, taken as the area between the teeth in the caps, square feet
A_u total riser area per tray, square feet
C_f liquid gradient factor
D clear liquid height in downflow above height of liquid at overflow weir (assuming no inlet weir), inches of clear liquid
F free height in downflow, inches
M correlating factor for obtaining the wet tray pressure drop from Figure 7
O_a maximum horizontal distance liquid travels in flowing over a weir and dropping down the downflow, measured from the weir, inches
Q clear liquid flow, gallons per minute
V total vapor rate per tray, cubic feet per second
V_s superficial slot vapor velocity, based on the total slot area, feet per second
$V_{s(min)}$ minimum superficial slot vapor velocity, feet per second

b distance between adjacent caps and/or uptakes in a row normal to flow of liquids, inches
d_c inside diameter of caps, inches
d_o total flowing clear liquid depth adjacent to overflow weir, inches
d_s cap slot height, inches
d_u inside diameter of risers, inches
h total vapor pressure drop per tray, inches of clear liquid
h_c total pressure drop through risers and caps on a wet tray, inches of water
h_d total pressure drop thru risers and caps on a dry tray, inches of water
h_r pressure drop thru the cap and riser reversal area, inches of water.
h_s pressure drop thru dry slots running wide open, inches of water
h_t depth of notches in weirs, inches
h_1 head of liquid flowing over weirs, inches of clear liquid
h_2 static submergence, difference in height of overflow weir and the top of slots, inches
h_3 pressure drop thru caps and risers for wet tray (assumes vapor is evenly distributed among the caps and risers), inches of clear liquid
$h_{3(max)}$ maximum pressure drop thru caps and risers resulting from operating with slots just wide open, inches of clear liquid
h_4 liquid pressure drop thru downflow constriction area, inches of clear liquid
l_w weir length, taken straight across top of weir, inches
l_3 total free space between caps normal to liquid flow, average of various rows, inches
l_2 total free space between risers normal to liquid flow, average of various rows, inches
m distance between top of risers and top of slots, inches
p_1 total pressure above liquid level, inches of clear liquid
p_2 total pressure below tray, inches of clear liquid
r number of rows of caps perpendicular to liquid flow
s Cap skirt clearance, distance of bottom edge of cap above tray floor, inches
t Tray spacing, inches
u superficial tower vapor velocity (based on total tower area), feet per second
w Minimum distance between caps and/or risers in adjacent rows of caps and risers, inches
$(b/w)_a$ Average of ratios of distances between caps and between risers

α l_2/l_3
β $(b/w)_a$
Δ liquid gradient, difference in clear liquid levels between inlet and outlet sides of tray or tray section, inches
$\Delta_{1.1}$ liquid gradient at condition of $u\sqrt{\rho_g} = 1.1$
Δ_x liquid gradient at condition of $u\sqrt{\rho_g} = x$
ρ_g vapor density, pounds per cubic feet
ρ_l liquid density, pounds per cubic feet

Note—The nomenclature, as shown above, has been corrected in two instances and should be used in preference to that printed in the August issue.

operating nearly wide open, then for larger liquid gradients the slots next to the weir will be bubbling underneath the skirt. Also, if several weir sections are to be used, the difference in height of each succeeding weir from the outlet side to the inlet side of the tray must be greater than $h_1+\Delta$, where h_1 is the height of liquid over the lower weir, and Δ is the liquid gradient in the section between the two weirs. If this condition does not obtain, then succeeding weirs will not act as true weirs but as partially or totally submerged weirs. If there are a number of sections then, it is obvious that the effective tray spacing will be appreciably reduced as the weirs become increasingly higher.

b) Vapor Pressure Drop

For most services the vapor pressure drop can be kept below 0.15 pounds per tray and usually around 0.1 pounds per tray. For high vacuum service the pressure drop should be 3 mm. Hg. per tray.

c) Downflow Free Height

To insure against priming due to insufficient free height in the downflow, it is best to design in accordance with the formula

$$\frac{D + h_t}{t} \leq 0.5 \qquad (20)$$

d) Downflow Residence Time

To insure sufficient vapor disengaging time in downflow the residence time of clear liquid in the total downflow volume (usually based on a downflow length equal to the tray spacing if no inlet weir is present) should be greater than 5 seconds. It frequently is well over 10 seconds for atmospheric towers.

e) Downflow Width

Even if the conditions in *c* and *d* are satisfied, the downflows may not function properly because they are too narrow and the downflowing liquid interferes with the upflowing disengaged vapors. The overflowing liquid should not reach over to the far side of the downflow as this space is where the vapor escapes from the liquid. An equation giving the minimum width of the downflow based on clear liquid and tray spacing is as follows:

$$O_a = \sqrt{h_1 t} \qquad (21)$$

The width of downflows become important in split flow trays with central downflows. In this type of tray, liquid enters the downflow from both sides and the vapor escapes from the center. Equation (21) gives the width of half of this type of downflow.

f) Maximum Slot Velocity

Since the slots next to the overflow weir will operate wider open due to liquid gradient than the average slot as determined by equation (9), it is preferable always to design for h_3 as determined by equation (9) in preference to equation (10). If equation (10) gives a smaller h_3 then more caps are required, so that h_3 as determined by equation (9) is the smaller value.

g) Minimum Slot Velocity

It has been observed that tray efficiencies drop off at low vapor rates. A rough correlation of this phenomena based on the point where the efficiencies of some commercial towers appeared to drop off appreciably and where pulsations occur, gives the minimum superficial slot velocities as follows:

$$V_{s\,(min)} = 3.4/\sqrt{\rho_v} \qquad (22)$$

h) Vapor Distribution Ratio

In order to have good vapor distribution through all rows of caps and to keep the cross flow of vapor over the tray to a low value, the vapor distribution ratio, Δ/h_v, must be kept low. It is recommended that the following be maintained:

$$\Delta/h_v < 0.40 \qquad (23)$$

In no case should it be above 0.60

i) Vapor Distribution Per Section

Equation (23) applies to the vapor distribution for one section since Δ is calculated for one section. If the tray has several sections each containing a weir, the sections should be so designed to give about equal liquid gradients. With equal liquid gradients each section then would give the same Δ/h_v. Since it is evident that it is desirable to have an even distribution of vapor over the whole tray, then the following must hold for each tray section:

$$h_s + h_v = \text{Constant} \qquad (24)$$

Equation (24) represents the flowing submergence, that is the sum of the static submergence and the head of liquid flowing over the weir, and shows that the flowing submergence must be equal for each tray section. A tray section with a long weir must have a slightly larger static submergence than a tray section with a short weir.

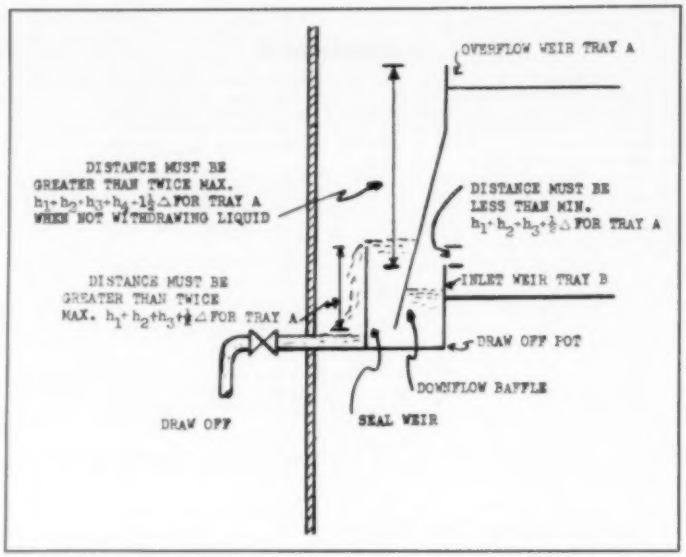
Procedure

A preliminary tray layout is made based on a downflow area sufficient to give at least five seconds residence in the whole downflow. If the liquid loading is much greater than 100 gpm. per one foot of tower diameter, split flow type of tray should be tried. The required number of caps can be approximated by taking the number of caps that would give a superficial slot velocity of $12.1/\sqrt{\rho_v}$. If the number of rows of caps are more than 12 to 15, a cascade type of tray with intermediate weirs could be tried.

After determining the type of tray and the number of caps to be tried first, the caps are layed out in such a manner as to be evenly distributed over the tray, keeping the spacing from each other and from the shell, weirs and downflows at least to 1½, 1, 3, 5 inches respectively. Such items as static submergence, skirt clearance, tray diameter and spacing, etc., will have been chosen before the tray layout is attempted, but some of them may have to be changed to obtain a tray with satisfactory characteristics as outlined under "Tray Features." These characteristics are calculated by the use of the foregoing equations and if the values are within the limits recommended, the tray layout is complete for the given loadings. However, as is usually the case, a few of the first trial values are not satisfactory so a new layout is tried until all characteristics are brought within the recommended limits. The more important characteristics that must be checked and kept within the recommended limits are as follows:

1) Downflow residence time.
2) Vapor distribution ratio.
3) Vapor pressure drop.
4) Free height in downflow.
5) Minimum and maximum superficial slot velocities.

The characteristics are also checked for different possible tray loading rates to make sure that they will remain satisfactory under all conditions of operation. The final acceptable tray layout will be a compromise of all desirable values of the different characteristics.


OVERFLOW WEIR TRAY A
DISTANCE MUST BE GREATER THAN TWICE MAX. $h_1+h_2+h_3+h_4-1\frac{1}{2}\Delta$ FOR TRAY A WHEN NOT WITHDRAWING LIQUID
DISTANCE MUST BE LESS THAN MIN. $h_1+h_2+h_3+\frac{1}{2}\Delta$ FOR TRAY A
INLET WEIR TRAY B
DISTANCE MUST BE GREATER THAN TWICE MAX. $h_1+h_2+h_3+\frac{1}{2}\Delta$ FOR TRAY A
DRAW OFF POT
DOWNFLOW BAFFLE
DRAW OFF
SEAL WEIR

CORRECTED Figure 3. Draw-Off with Seal. Certain corrections have been made by the author and the above should be used in preference to the one printed in the August issue.

Example

Figure 8 shows a typical layout for a tray that is to operate at pressures close to atmospheric pressure. This means that the tray loading will be high vapor and low liquid capacity as compared with the loading that would be experienced at high pressures. Hence, a single pass tray is satisfactory and, as the diameter is not particularly large, no intermediate weirs are required.

Figure 9 shows the tray and cap dimensions, and the calculated values for the condition of maximum liquid and vapor loading. These appear to be well within the recommended values. The liquid gradient is somewhat on the high side, but is satisfactory since the ratio, Δ/h_v, is low and the slots are not, on the average, running quite wide open.

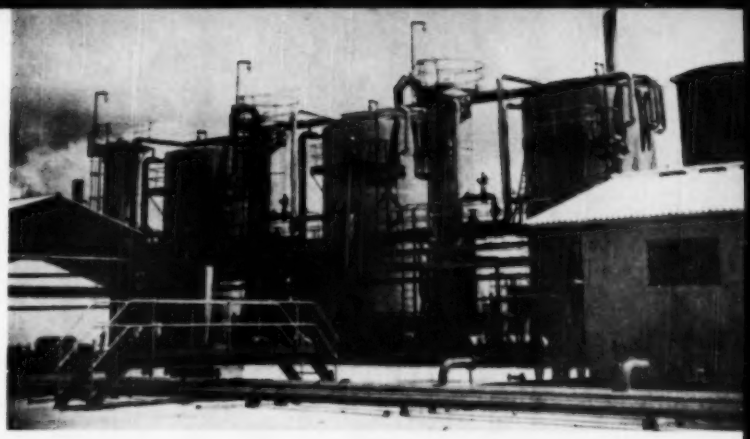
Figure 10 shows the case for maximum liquid and minimum vapor loading for the same tray. These loadings shown in Figures 8 and 9 are not the maximum and minimum the tray could bear, but represent the expected conditions that this particular tray installation was to meet. The ratio, Δ/h_v, as expected, is larger for the conditions of Figure 9, but is satisfactory.

ACKNOWLEDGMENT

The writer wishes to acknowledge the help of A. C. Parlett in working up this material.

REFERENCES

See Part I, used in the August issue, for all references.



Doctor Treating Unit at Shell's Refinery, Cardon, Paraguana Peninsula, Venezuela.

Lube Unit Being Added To Cardon Plant by Shell

CONCEIVED during the war years and started in 1945, construction of The Venezuelan Oil Concessions Ltd. (Shell's) Cardon refinery in Venezuela has made good progress and the bulk of the units are now in operation. The first plant, the crude distilling unit, went on stream in February, 1949, and since then the vacuum unit, the cracking units, the reforming unit, the gas recovery units, the polymerization unit and others have been put into operation.

Now a comprehensive lubricating oil complex, comprising a de-asphalting unit of 2560-barrel-daily capacity, a furfural extraction unit (6350 barrels daily), solvent dewaxing unit (3520 barrels daily), clay contacting unit (3700 barrels daily) is being constructed. It is expected that these will be completed during the second half of 1951 and will turn out 2000 to 2500 barrels daily of high-grade lubricating oils.

First construction was handicapped by manpower and material shortages as well as by the isolated desert-like conditions of the Paraguana Peninsula on whose southwestern corner the plant is located. Final plans called for not only the extensive refinery but a complete city capable of accomodating 10,000 inhabitants. In the latter work no temporary structures were erected but, rather, only permanent buildings from the very start. C. P. Louwerse has been manager on the spot since the first party of six men landed in a row-boat on the barren coast in March, 1945.

The refinery is located on a 1275-hectare plot (3175 acres) with coastal frontage of some four miles. Sheltered deep water to the west was the determining factor governing the choice of the site. Shell production in the area surrounding Lake Maracaibo gives the refinery its crude supply.

The refinery itself is laid out in the southern half of the plot which leaves the northern part for the residential, social and shopping areas, the two sections being separated by a strip of open ground.

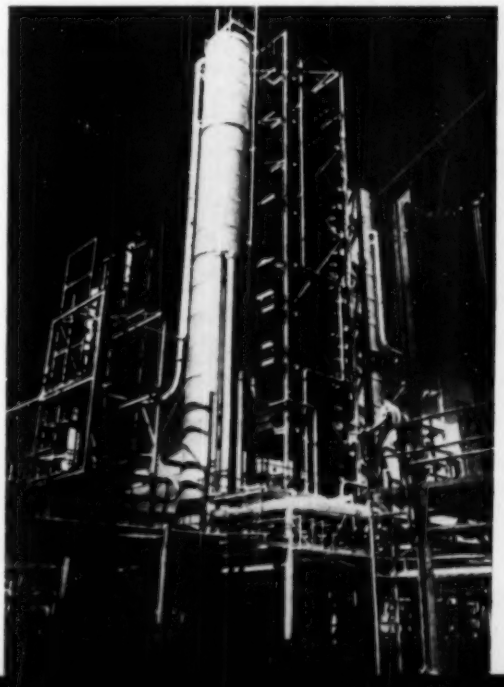
Two reinforced concrete jetties were among the first technical facilities built with berthing space provided for four shallow-draft lake vessels and four ocean tankers.

Basic refinery units are as follows:

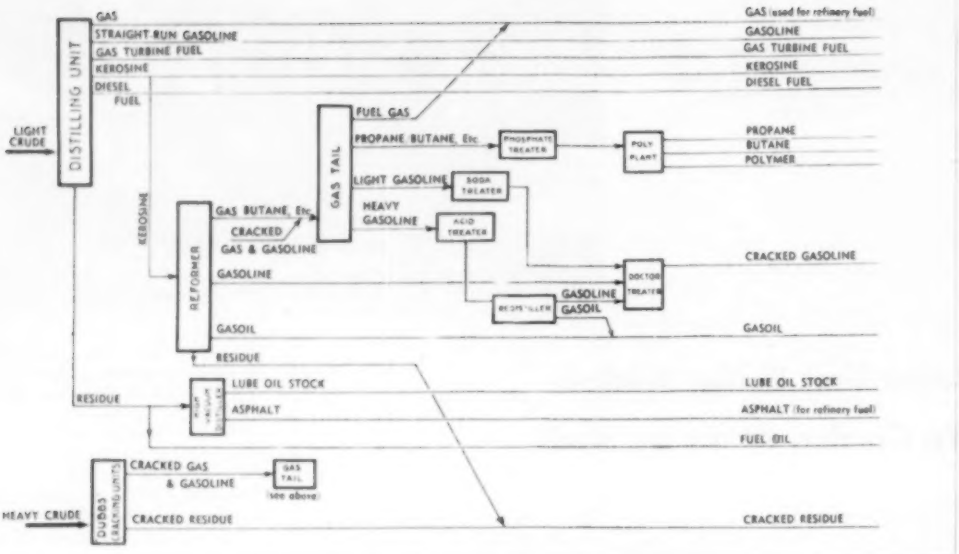
The distilling unit is designed for 38,000 barrels daily 34-API gravity crude intake. For refinery and export crude a storage capacity of approximately 1.2 million barrels is provided. The unit consists of a primary column, a secondary or vacuum column, a gasoline rerun column, and a stabilizer. The primary and secondary columns are provided with side-cut strippers to obtain the desired fractions. The end products of this unit are gas for refinery fuel, straight-run gasoline, naphtha, kerosine, gasoil and residual fuel.

The Vacuum Unit: The bottom product of the secondary column, which is a long residue, is redistilled in a high-vacuum tower, provided with side-cut strippers to produce basic lubricating stocks and short residue. To be able to handle feedstocks, containing naphthenic acid, the unit is equipped with a caustic extraction system.

The Cracking Units: Comprising two identical thermal cracking units, these are built with a capacity of about 11,000 barrels daily each for processing a heavy 13° API crude, converting this crude oil into gasoline, gasoil and a bunker fuel oil. Be-



View of Columns, Crude Distillation Unit. The primary tower D-1 and Secondary Tower D-5 are in foreground, the stabilizer column D-4 and re-run tower D-3 in background.



Simplified Flow Diagram, Cardon Refinery, The Venezuelan Oil Concessions, Ltd.

sides customary reaction and high-pressure flash chambers, the units are also provided with a low-pressure flash chamber, operating at about 5 psi., allowing an extremely deep flash of the cracked residue, the flashed distillate being recycled via the fractionating tower through to the cracking furnace. The lightest fractions are charged to a gas recovery unit together with similar fractions from the reformer.

The reforming unit is a conventional UOP-type reformer, upgrading a low octane straight run naphtha into a marketable motor gasoline component.

The gas recovery unit consists of a rectifying absorber and stripper and a gasoline splitter. A dry gas, mainly consisting of ethane and lighter components, is produced as absorber top gas. The absorber bottom is debutanized in the stripper, the stripper bottom being further fractionated in the gasoline splitter. The heavy gasoline or gasoline splitter bottom is used as lean oil for the absorber. The absorber is provided with a small section at the top where cracked gas oil from the cracking units is circulated as sponge oil.

There are four treating units, namely, phosphate, soda, acid, and a doctor treater.

The Phosphate Treater: The Shell Phosphate Process is applied for treating of the C^3-C^4 fraction from the cracking and reforming units to remover H^2S. This fraction is subsequently scrubbed with caustic to remove mercaptans, prior to being charged to the poly unit.

The Soda or Light Tops Treater: After being given a prewash with salt water, cracked and reformed tops are treated countercurrently for removal of H^2S and mercaptans. The unit is of the continuous mixing-settling type.

The acid treater consists of two identical units for the sulfuric acid treating of heavy cracked gasoline in a countercurrent two-stage mixing-settling type plant.

A conventional continuous *doctor treater* treats light and heavy cracked and reformed gasolines, the spent doctor solution being regenerated in a three-stage recovery unit.

In the redistillation unit acid treated gasolines are redistilled to remove the polymers formed during the acid treatment.

In the polymerization unit the combined treated C^3-C^4 fractions are catalytically polymerized and subsequently stabilized to yield a polymer gasoline suitable for blending in motor gasoline.

To supply the Cardon refinery and its living area, utilities have been erected as follow:

Steam Generation Plant: The generator turbines of the power plant are driven by 500-psi. steam, produced in three high-pressure. Low-pressure (250-psi.) steam, necessary as process steam in the various refinery processes, is produced by four low-pressure boilers. Feed water for these boilers is lime-soda treated in a water softening plant and subsequently phosphate conditioned.

Power Supply: Virtually all pumps and spares are electric driven and power is supplied by four 10,000-hp. condensing turbines, each driving an alternator of 7500 kilowatts. The electric supply for light and power is divided over 16 transformer stations.

Water supply is two fold: Salt water is used as cooling and fire water; fresh water for chemical solutions, boiler feed water and domestic water. After the erection of the lubeoil project it is expected that about 30,000 tons per hour of cooling water will be used in once-through operation, requiring no cooling towers. Presently there are two electric-driven and two turbo-driven centrifugal pumps each having a capacity of about 6000 tons per hour. One electric-driven and two Diesel-driven pumps each of 500 tons per hour capacity are installed as fire pumps.

Fresh water has until recently been supplied by a salt water distiller of 1100 tons per day capacity and four distillers of 150 tons per day each. From now on fresh water will be supplied through a joint Shell-Creole-Venezuelan Government 30 and 34-inch pipe line gravitating water over a distance of 80 miles from springs and wells near Coro on the mainland to Cardon as well as to Creole's Amuay Bay Refinery.

Fuel supply will consist of refinery gas as well as a residual fuel.

Most of the refinery units were designed by The Lummus Company and UOP, and some were of Shell's own design. The major part of the refinery construction work was carried out by Lummus.

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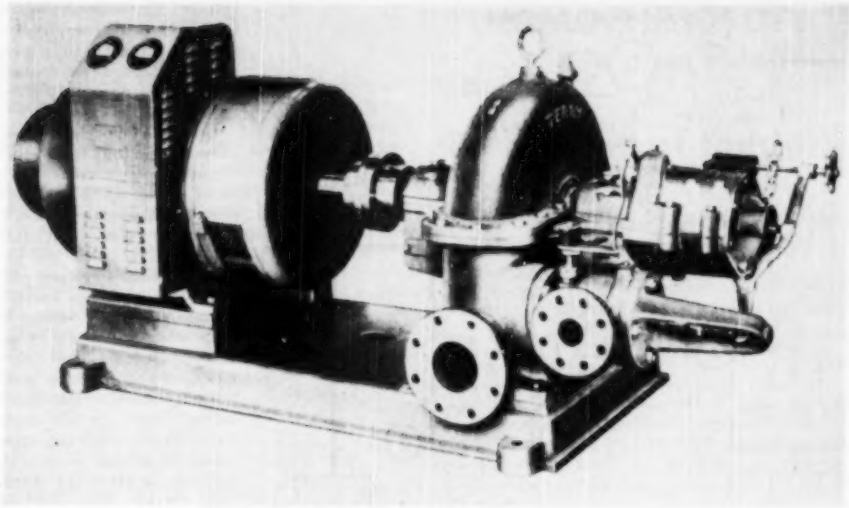

Figure 1. Small Turbo Generator.

Emergency Electrical Equipment Justified As Initial Plant Investment

JOHN M. CROTHERS
Catalytic Construction Company, Philadelphia

IMPORTANT process units in modern refineries are designed for long on-stream periods and high productivity. The on-stream periods are of major importance and careful consideration should be given to the ability of emergency electrical power to maintain these periods or to greatly assist in reducing the time of return to full on-stream operations on loss of normal power.

The primary factor in determining the advisability of an emergency installation is the total cost in relation to the accumulated savings afforded by maintaining full or partial production during normal power failures. Infrequent power failures of short durations, not causing complete shut-downs or long periods of return to full on-stream operations, will not justify such an expenditure.

Frequent power failures of long durations, to important process units, will usually more than justify such an expenditure. Infrequent power failures of long durations must be carefully considered. Power failures of long durations resulting in a complete unit shutdown, in most refineries today, are infrequent and steam-driver alternates are usually provided in the initial design for emergency and maintenance purposes. The problem then resolves itself around the question of keeping a careful check on levels, temperatures, flows, pressures, etc., and upon the ability to control specific essential operations at remote points where time of change-over is important.

Stand-by banks of batteries have been installed in some instances, which require constant maintenance, possible corrosive gas conditions and will not operate control circuits, motors, relays, solenoids or synchronous motor driven instruments charts using alternating current equipment. Direct current circuit tripping devices are, to a large extent, being superseded by alternating current reactor and capacitor tripping devices. For these reasons it is usually advantageous to install a small turbo-generator as illustrated by Figure 1, and a manual reset solenoid operated steam to turbine valve which automatically opens when the solenoid is de-energized. A description of a recent installation requiring three-phase and single-phase emergency power, shown schematically by Figure 2, will illustrate the design and the component parts of this emergency electrical power installation.

This installation is chosen for description because it illustrates a dual-voltage requirement, which is rather unusual. Many variations of this de-

PROFITABLE operation of refinery process units requires long on-stream periods without shutdowns other than those provided in the economics of the unit's design. Unscheduled downtime is extremely costly and is the primary reason for inclusion of standby equipment at critical service points in the process.

Failure to provide standby, or emergency, electrical power has often been responsible for the shutdown of process units when the unit was otherwise operating efficiently at capacity. Emergency electrical equipment can frequently be justified as initial plant investment, when this investment is weighed against the high cost of unscheduled downtime.

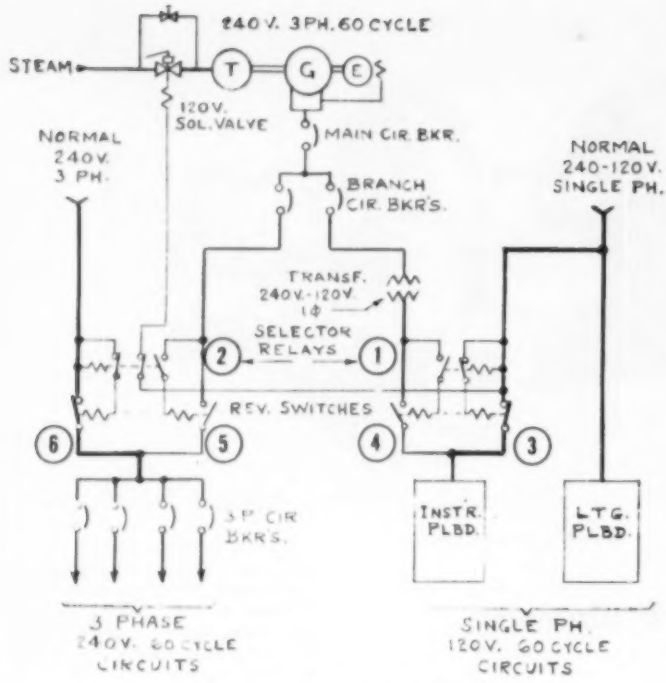

Figure 2. Emergency Electrical Power Installation.

sign can be made and separate parts can be utilized to fit almost any emergency power problem. The installation serves 240-volt, 3-phase, 60-cycle power to motors of motor-operated valves and 120-140-volt, single-phase, 60-cycle current to a separate panelboard, designated as the instrument panelboard. The 120-volt circuits in this panelboard serve the sound powered telephone signal system, alarms, all control and indicating systems, instruments, emergency lights and aircraft warning lights. The decision to provide emergency power for the motor-operated valves was due to the necessity for speed of operation and because their various locations made quick manual operation practically impossible. The 120-volt control and indicating circuits for these valves are supplied from the instrument panelboard, so complete emergency operations can be performed from the main control panels.

The size of the turbo-generator was determined by load requirements of the maximum number of motor-operated valves starting simultaneously, plus the normal demand of the instrument panelboard. Careful consideration of generator capacity should be made realizing the difference between generator voltage regulation and transformer voltage regulation. This regulation should be capable of sustaining contactor and relay coils during maximum starting current demands. Low or slow generator voltage regulation will result in a hunting or pumping effect. The turbine governor should be capable of close speed regulation to avoid high voltage when the solenoid operated steam valve snaps open on loss of normal power. A small manual steam valve is installed to by-pass the solenoid steam valve, which permits sufficient steam to keep the turbo-generator heated and rotating slowly, thereby ready for immediate service.

The 3-phase requirements of the motor-operated valves determined the electrical characteristics of the generator and the addition of the 240-volt to 120-240-volt single-phase transformer was required to supply the instrument panelboard circuits. Individual circuit protection is afforded by circuit breakers for each type of load. The generator is protected by its built-in equipment and the main generator external circuit breaker. These breakers also serve to isolate the separate circuits and the generator in case of faults and for periodic maintenance.

On loss of normal 120-volt power to the instrument panelboard the solenoid of the steam valve is de-energized, the valve opens and the turbine speeds up to the required rpm, generating proper voltage. Simultaneously the selector relay (1) is de-energized opening reversing contacts (3), proper emergency voltage closes contacts (4) and supplies all circuits of the instrument panelboard.

On loss of normal 240-volt, 3-phase power to the four motor-operated valve circuits selector relay (2) is de-energized, which opens the contact and de-energizes the solenoid and opens steam to turbine valve. In a similar manner contacts (5) opens and contacts (6) closes which supplies power to the four motor-operated valve circuits. On return of normal voltage to either or both selector relays (1) and (2), the relays open the coil circuit of the emergency contactors and close the normal contactors automatically. Indicating lights on the motor-operated valve circuit warn the operator of the return of normal power. Normal lights indicate the return of normal 120-240-volt service. The solenoid operated steam to turbo-generator valve is then reset and the system is prepared for another power failure.

A short time lag in rise of generator voltage and the proper design of solenoid operated steam valve coil and relay coils will not permit automatic throw-over during voltage dips of the normal power. The reversing contactors (3), (4) and (5), (6) are mechanically interlocked to prevent any possibility of a connection between normal and emergency services.

Selective relays (1) and (2) were required because the two normal different voltages are from separate feeders. In this design, loss of either service operates the turbo-generator to supply the respective voltage or loss of both operates the turbo-generator to supply both voltages simultaneously.

These emergency turbo-generators of required capacities, usually 10 to 25 kilowatts are normally small and often can be located in back of the control panels, where the complete installation can be made compact, thereby reducing installation costs. Complications should be avoided. The design should incorporate the minimum number of relays and contactors required for quick and reliable operation.

An emergency installation providing 10 kilowatts at 120-240 volts, single phase, 60 cycle, either manual or automatic, serving a few required lights, important recording and indicating instruments, the alarm system and essential process controls during stand-by, change-over or complete shutdown, will be a valuable factor in reducing or entirely eliminating the time required to return to full on-stream operations in many important refinery process units, in the event of a main electrical power failure.

THERMOCHEMISTRY for the Petrochemical Industry

Part XIII—Some Oxygenated Hydrocarbons, C_1 and C_2

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University of Texas, Austin

SINCE THIS series was begun, the thermochemical properties of a large number of compounds have been presented: paraffinic hydrocarbons,[19] monoolefinic hydrocarbons,[20] cycloparaffinic hydrocarbons,[21] aromatic hydrocarbons,[22] acetylenic and diolefinic hydrocarbons,[23] combustion gases,[24] sulfur compounds,[25] halogens and halogen acids,[26] chloromethanes,[27] cyanogen compounds,[28] and the oxides of nitrogen.[29] This paper now presents the data for some oxygenated hydrocarbons — formaldehyde, acetaldehyde, methanol, ethanol, ethylene oxide, and ketene.

Dr. Kobe is a professor of chemical engineering at the University of Texas and Mr. Pennington is the 1949-1950 Celanese Corporation fellow in Chemical Engineering there.

TABLE 1 presents sources of heat capacity data for formaldehyde, acetaldehyde, methanol, ethanol, ethylene oxide, and ketene. The temperature range, method of derivation of the data, and reference is given in each case.

The data presented for formaldehyde were derived from the results presented by Hamner and Matsen[30] in a progress report for the Celanese Fellowship in Chemical Physics at the University of Texas. These data were presented as an improvement on the results of Thompson[40] and Stevenson and Beach,[38] and were therefore given preference in this paper.

In the case of acetaldehyde, the latest data available, those of Pitzer and Weltner,[32] were used to obtain the results presented here. These authors made a new vibrational assignment, using the original data from which Morris[31] and Thompson and Harris[41] had made assignments, which bring the resulting thermodynamic data into

TABLE 1

Reported Heat Capacity Data for Some Oxygenated Hydrocarbons

Compound	Temperature Range	Method	Workers	Reference
Formaldehyde	273 to 1500° K.	Spectroscopic	Matsen and Hamner	30
	298 to 1500° K.	Spectroscopic	Thompson	40
	291 to 1500° K.	Spectroscopic	Stevenson and Beach	38
Acetaldehyde	30° C.	Velocity of Sound	Shaha	34
	298 to 1500° K.	Spectroscopic	Smith	35
	298 to 1500° K.	Spectroscopic	Morris	31
	298 to 1000° K.	Spectroscopic	Pitzer and Weltner	32
Methanol	298 to 1000° K.	Spectroscopic	Smith	36
	298 to 1500° K.	Spectroscopic	Hurd	15
	75 to 170° C.	Calorimetric	DeVries and Collins	6
	100 to 223° C.	Calorimetric	Regnault	33
	90° C.	Velocity of Sound	Stevens	37
	340° C.	Calorimetric	Thibaut	39
	77°	Velocity of Sound	Dixon and Greenwood	7
Ethanol	437 to 623° K.	Calorimetric	Regnault	33
	90° C.	Velocity of Sound	Dixon and Greenwood	7
	410° K.	Calorimetric	Bennewitz and Rossner	3
	90 to 350° C.	Velocity of Sound	Jatkar	16
	300 to 1000° K.	Spectroscopic	Aston	2
	298 to 1500° K.	Spectroscopic	Brickwedde, Moscow and Aston	4
Ethylene Oxide	298 to 1000° K.	Spectroscopic	Godnev and Morosov	11
	25 to 500° C.	Spectroscopic	Gunthard and Heilbronner	13
	307 to 371° K.	Spectroscopic	Ginque and Gordon	10
	272 to 370° K.	Calorimetric	Kistiakowsky and Rice	18
Ketene	250 to 900° K.	Spectroscopic	Drayton and Thompson	9

TABLE 2

Free Energies of Formation, Heats of Formation, Heats of Combustion, and Molecular Weights of Some Oxygenated Hydrocarbons, at 25° C.[1]

Compound	Molecular Weight	$-\Delta G_f^\circ$ cal./g-mole	$-\Delta H_f^\circ$ cal./g-mole	$-\Delta H_c^\circ$ cal./g-mole H_2O (liq.) CO_2 (gas)	$-\Delta H_c^\circ$ cal./g-mole H_2O (gas) CO_2 (gas)
Formaldehyde (g)	30.026	26,200	27,700	134,670	124,150
Acetaldehyde (g)	44.052	31,960	39,760	284,980	263,940
Methanol (g)	32.042	38,700	48,100	182,590	161,550
(l)		39,750	57,036	173,650	152,610
Ethano (g)	46.068	40,300	56,240	336,820	305,260
(l)		41,770	66,356	326,700	295,140
Ethylene Oxide (g)	44.052	2,790	12,190	312,550	291,510
Ketene (g)	42.036		14,600	241,820	231,300

[1] — ΔH_c represents the heat evolved at 25° C. and constant pressure in the combustion of the compounds (in some indicated state) in gaseous oxygen to form the products indicated. All reactants and products are in their appropriate standard reference states.

ΔH_f° and ΔG_f° represent the changes in heat content (enthalpy) and free energy respectively, for the formation of the compounds in the indicated state from carbon, hydrogen, and oxygen, with all reactants and products in appropriate standard reference states.

TABLE 3

Heat Capacities of Some Oxygenated Hydrocarbons cal./g-mole · °C.

°C.	Formaldehyde	Acetaldehyde	Methanol	Ethanol	Ethylene Oxide	Ketene
0	8.281	12.39	10.27	16.75	10.74	10.93
18	8.391	12.87	10.63	17.36	11.27	11.29
25	8.441	13.06	10.76	17.59	11.54	11.43
100	9.082	15.62	12.20	20.12	13.83	12.93
200	10.129	17.62	14.04	23.30	17.23	14.65
300	11.204	19.95	15.78	26.12	20.00	16.06
400	12.204	22.00	17.39	28.58	22.23	17.23
500	13.109	23.77	18.83	30.72	24.14	18.24
600	13.917	25.30	20.12	32.60	25.76	19.10
700	14.611	26.64	21.28	39.25	27.14	19.85
800	15.208	.....	.....	35.70	.....	20.50
900	15.726	.....	.....	36.97	.....	21.06
1000	16.176	.....	.....	38.07	.....	21.56
1100	16.565	.....	.....	39.03	.....	21.99
1200	16.900	.....	.....	39.87	.....	22.36

TABLE 4

Heat Capacities of Some Oxygenated Hydrocarbons cal./g-mole · °K.

°K.	Formaldehyde	Acetaldehyde	Methanol	Ethano	Ethylene Oxide	Ketene
273	8.281	12.39	10.27	16.75	10.74	10.93
291	8.391	12.87	10.63	17.36	11.27	11.29
298	8.441	13.06	10.76	17.59	11.54	11.43
300	8.465	13.11	10.80	17.66	11.60	11.97
400	9.349	15.73	12.70	21.00	14.75	13.42
500	10.420	18.27	14.52	24.09	18.03	15.05
600	11.481	20.52	16.23	26.81	20.62	16.39
700	12.455	22.50	17.79	29.18	22.78	17.52
800	13.336	24.20	19.19	31.25	24.60	18.48
900	14.116	25.68	20.44	33.07	26.15	19.31
1000	14.778	26.96	21.57	34.66	27.47	20.03
1100	15.355	.....	.....	36.06	.....	20.66
1200	15.853	.....	.....	37.28	.....	21.20
1300	16.287	.....	.....	38.34	.....	21.68
1400	16.660	.....	.....	39.27	.....	22.09
1500	16.982	.....	.....	40.08	.....	22.45

TABLE 5

Heat Capacities of Some Oxygenated Hydrocarbons
Btu./lb.-mole · °F.

°F.	Formaldehyde	Acetaldehyde	Methanol	Ethanol	Ethylene Oxide	Ketene
32	8.281	12.39	10.27	16.72	10.74	10.93
50	8.378	12.81	10.58	17.27	11.19	11.26
77	8.441	13.06	10.76	17.59	11.51	11.43
100	8.545	13.30	11.01	18.04	11.96	11.70
200	9.017	14.84	12.07	19.91	13.82	12.80
300	9.579	16.31	13.11	21.72	15.62	13.81
400	10.176	17.72	14.12	23.43	17.32	14.71
500	10.790	19.05	15.10	25.03	18.87	15.52
600	11.390	20.28	16.04	26.52	20.29	16.25
700	11.925	21.43	16.94	27.90	21.58	16.91
800	12.454	22.50	17.79	29.18	22.74	17.52
900	12.955	23.47	18.58	30.36	23.78	18.07
1000	13.426	24.37	19.33	31.46	24.74	18.58
1100	13.867	25.21	20.03	32.49	25.62	19.04
1200	14.272	25.98	20.70	33.44	26.43	19.48
1300	14.639	26.69	21.32	34.32	27.17	19.88
1400	14.979	.....	.....	35.14	.....	20.25
1500	15.294	.....	.....	35.91	.....	20.59
1600	15.585	.....	.....	36.62	.....	20.91
1700	15.852	.....	.....	37.28	.....	21.20
1800	16.100	.....	.....	37.88	.....	21.47
1900	16.330	.....	.....	38.45	.....	21.73
2000	16.541	.....	.....	38.97	.....	21.96
2100	16.735	.....	.....	39.46	.....	22.17
2200	16.913	.....	.....	39.91	.....	22.37

TABLE 6

Heat Capacities of Some Oxygenated Hydrocarbons
Btu./lb.-mole · °R.

°R.	Formaldehyde	Acetaldehyde	Methanol	Ethanol	Ethylene Oxide	Ketene
492	8.281	12.39	10.27	16.72	10.74	10.93
500	8.308	12.52	10.36	16.88	10.81	11.03
520	8.378	12.81	10.58	17.27	11.19	11.26
537	8.441	13.06	10.76	17.59	11.51	11.43
600	8.720	13.96	11.44	18.80	12.72	12.19
700	9.236	15.44	12.49	20.64	14.54	13.22
800	9.817	16.89	13.52	22.42	16.32	14.19
900	10.420	18.27	14.52	24.09	17.96	15.05
1000	11.019	19.56	15.48	25.65	19.46	15.82
1100	11.595	20.75	16.41	27.09	20.82	16.52
1200	12.142	21.87	17.28	27.43	22.06	17.16
1300	12.659	22.90	18.11	29.66	23.17	17.75
1400	13.149	23.84	18.89	30.81	24.18	18.28
1500	13.608	24.72	19.62	31.88	25.11	18.77
1600	14.034	25.53	20.30	32.88	25.96	19.22
1700	14.424	26.27	20.96	33.80	26.74	19.65
1800	14.778	26.96	21.57	34.66	27.45	20.03
1900	15.108	.....	.....	35.46	.....	20.39
2000	15.414	.....	.....	36.20	.....	20.72
2100	15.695	.....	.....	36.89	.....	21.03
2200	15.954	.....	.....	37.52	.....	21.31
2300	16.195	.....	.....	38.11	.....	21.58
2400	16.418	.....	.....	38.66	.....	21.83
2500	16.621	.....	.....	39.17	.....	22.05
2600	16.808	.....	.....	39.63	.....	22.25
2700	16.982	.....	.....	40.08	.....	22.45

agreement with the calorimetric data of Coleman and De Vries[5] and equilibrium data between hydrogen and ethanol. Smith[35] used the original assignments mentioned above and his data do not agree too well with experiment.

Smith[36] presents calculated data for methanol which agree well with the numerous calorimetric data cited in Table 1 if these data are considered as apparent heat capacities of an equilibrium mixture of associated and non-associated molecules. Methanol definitely shows evidence of association in the vapor state at near saturation temperatures. These data were used in obtaining the results presented here.

Ethanol has also been the subject of considerable research as indicated in Table 1. Aston[2] made calculations from spectroscopic data, and later Brickwedde, Moscow, and Aston[4] presented the revised results which were used to derive the data presented here.

Ethylene oxide has been the subject of considerable study in the past few years. Numerous vibrational analyses have been carried out and different assignments presented.

TABLE 7

Enthalpies of Some Oxygenated Hydrocarbons
cal./g-mole

°C.	Formaldehyde	Acetaldehyde	Methanol	Ethanol	Ethylene Oxide	Ketene
0	0.0	0.0	0.0	0.0	0.0	0.0
18	150.0	228.4	188.1	306.7	197.5	200.0
25	209.0	319.2	263.0	429.0	277.0	279.6
100	864.9	1309	1122	1849	1234	1193
200	1824.6	3004	2434	4020	2796	2577
300	2891.7	4884	3924	6642	4656	4115
400	4062.8	6984	5580	9228	6772	5780
500	5329.0	9275	7390	12200	9085	7556
600	6681.6	11730	9336	15370	11610	9424
700	8108.8	14330	11400	18710	14220	11370
800	9600.0	.....	.....	22210	.....	13390
900	11148.	.....	.....	25840	.....	15470
1000	12743.	.....	.....	29600	.....	17660
1100	14381.	.....	.....	33450	.....	19708
1200	16055.	.....	.....	37400	.....	22000

Kistiakowsky and Rice[18] made revisions to bring the calculated heat capacity into agreement with their experimental results. However, Giaque and Gordon[10] find that their revised data do not result in a value for entropy which

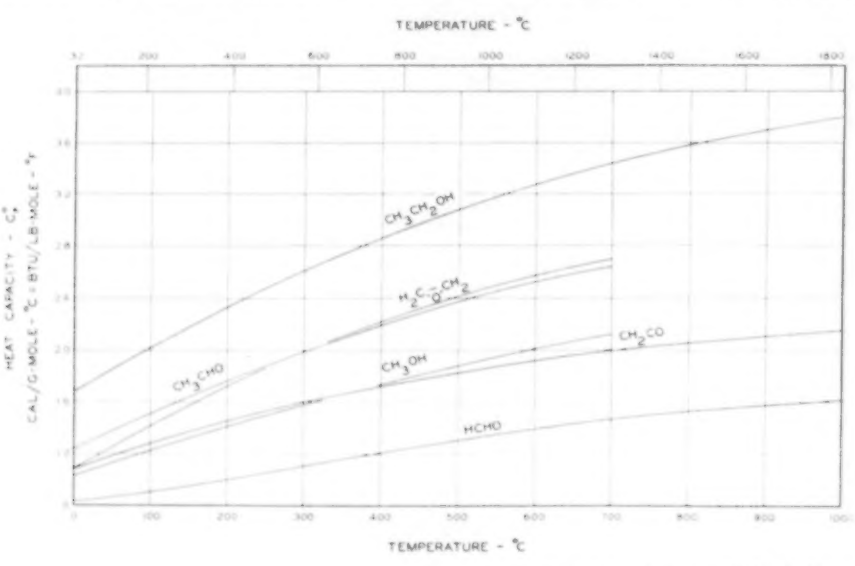

Figure 1. Heat capacity curves for Formaldehyde, Acetaldehyde, Methanol, Ethanol, Ethylene Oxide and Ketene.

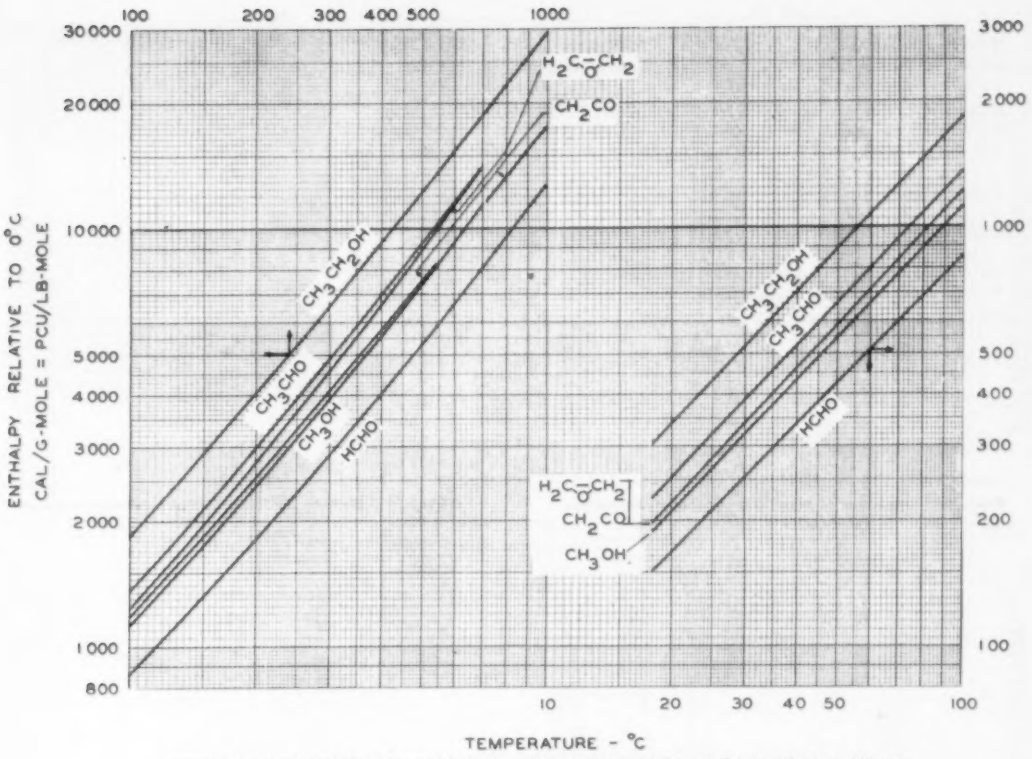

Figure 2. Relative Enthalpies of Formaldehyde, Acetaldehyde, Methanol, Ethanol, Ethylene Oxide and Ketene

gives a favorable comparison with that experimentally obtained by them. Both of the papers mentioned above point out that more experimental work is required before very accurate data may be obtained for ethylene oxide. Arnold[3] has studied all the papers listed in Table 1 and presents data in essential agreement with that of Godnev and Morozov.[11] These data were used in the preparation of the values presented for ethylene oxide in this paper.

There are no calorimetric data available for ketene. Drayton and Thompson[5] present calculated data from 250° to 900° Kelvin but there is some confusion as to the possible vibrational assignments. The data presented in this paper were calculated from the assignment of Halverson and Williams.[14]

The latest available data for heats and free energies of formation, heats of combustion, and molecular weights are given in Table 2, being taken from the compilation of "Selected Values of Chemical Thermodynamic Properties" of the National Bureau of Standards.

The molar heat capacities on all temperature scales are presented in Tables 3, 4, 5, and 6, the fundamental data in all cases having been presented on the Kelvin scale. The data on the Centigrade scale are plotted in Figure 1 to illustrate graphically the relationship of heat capacity

TABLE 8

Enthalpies of Some Oxygenated Hydrocarbons
cal./g-mole

K.	Formaldehyde	Acetaldehyde	Methanol	Ethanol	Ethylene Oxide	Ketene
273	0.0	0.0	0.0	0.0	0.0	0.0
291	150.05	227.4	188.1	306.7	197.4	200.0
298	205.96	318.2	263.0	429.0	277.1	279.8
300	224.51	342.3	282.8	467.5	298.1	300.7
400	1112.5	1784	1458	2400	1621	1547
500	2100.5	3487	2820	4657	3267	2974
600	3196.3	5429	4356	7206	5198	4548
700	4393.9	7583	6058	10100	7373	6245
800	5684.1	9921	7909	13030	9737	8046
900	7057.9	12420	9892	16250	12270	9937
1000	8503.3	15050	11990	19630	14960	11904
1100	10011	.....	.....	23170	.....	13940
1200	11572	.....	.....	26840	.....	16033
1300	13179	.....	.....	30620	.....	18177
1400	14827	.....	.....	34500	.....	20367
1500	16509	.....	.....	38470	.....	22594

TABLE 9

Enthalpies of Some Oxygenated Hydrocarbons
Btu./lb.-mole

F.	Formaldehyde	Acetaldehyde	Methanol	Ethanol	Ethylene Oxide	Ketene
32	0.0	0.0	0.0	0.0	0.0	0.0
60	233.26	353.0	291.8	475.8	305.7	310.7
77	376.13	572.8	473.4	772.2	498.8	503.3
100	571.59	877.1	722.8	1182.0	768.6	769.3
200	1448.7	2288	1875	3080	2056	1985
300	2378.0	3846	3130	5161	3526	3317
400	3365.5	5548	4497	7419	5173	4744
500	4413.4	7387	5953	9843	6984	6257
600	5520.8	9354	7509	12420	8942	7846
700	6685.6	11440	9158	15140	11050	9504
800	7904.7	13640	10890	18000	13270	11226
900	9175.4	15940	12700	20970	15590	13096
1000	10495	18330	14590	24070	18010	14839
1100	11860	20810	16550	27290	20530	16720
1200	13267	23370	18590	30560	23140	18647
1300	14713	26000	20690	33950	25820	20615
1400	16194	.....	.....	37420	.....	22622
1500	17708	.....	.....	40980	.....	24664
1600	19252	.....	.....	44600	.....	26739
1700	20824	.....	.....	48300	.....	28845
1800	22422	.....	.....	52060	.....	30978
1900	24043	.....	.....	55870	.....	33139
2000	25687	.....	.....	59740	.....	35323
2100	27351	.....	.....	63670	.....	37530
2200	29033	.....	.....	67630	.....	39757

TABLE 10

Enthalpies of Some Oxygenated Hydrocarbons
Btu./lb.-mole

°R.	Formaldehyde	Acetaldehyde	Methanol	Ethanol	Ethylene Oxide	Ketene
492	0.0	0.0	0.0	0.0	0.0	0.0
500	68.98	103.5	88.8	156.9	89.2	91.3
520	233.26	353.0	291.8	475.8	305.7	310.7
537	571.59	572.8	473.4	772.2	498.8	503.3
600	919.40	1428	1180	1932	1265	1248
700	1816.5	2899	2377	3904	2624	2518
800	2768	4513	3678	6058	4171	3890
900	3780.6	6277	5079	8383	5881	5353
1000	4852.7	8165	6580	10870	7762	6897
1100	5983.6	10180	8174	13510	9778	8514
1200	7171.5	12310	9859	16280	11930	10199
1300	8411.7	14550	11620	19190	14200	11945
1400	9702.4	16890	13480	22210	16560	13747
1500	11040	19320	15400	25350	19017	15600
1600	12423	21840	17400	28580	21570	17499
1700	13846	24430	19460	31920	24210	19443
1800	15306	27090	21580	35340	26930	21427
1900	16801			38850		23449
2000	18327			42430		25504
2100	19883			46080		27592
2200	21466			49810		29709
2300	23073			53590		31854
2400	24704			57430		34024
2500	26356			61320		36219
2600	28028			65260		38434
2700	29717			69250		40669

TABLE 11

Mean Heat Capacities of Some Oxygenated Hydrocarbons
cal./g-mole • °C.

°C.	Formaldehyde	Acetaldehyde	Methanol	Ethanol	Ethylene Oxide	Ketene
0	8.281	12.39	10.27	16.72	10.74	10.93
18	8.336	12.69	10.45	17.04	10.97	11.11
25	8.358	12.77	10.52	17.16	11.08	11.18
100	8.649	13.59	11.22	18.49	12.34	11.95
200	9.123	15.02	12.17	20.10	13.98	12.89
300	9.639	16.28	13.08	22.14	15.32	13.72
400	10.157	17.46	13.95	23.07	16.93	14.45
500	10.658	18.55	14.78	24.40	18.17	15.11
600	11.136	19.55	15.56	25.62	19.35	15.71
700	11.584	20.47	16.29	26.73	20.31	16.24
800	12.000			27.76		16.74
900	12.387			28.71		17.19
1000	12.743			29.60		17.60
1100	13.074			30.41		17.98
1200	13.379			31.17		18.33

TABLE 12

Mean Heat Capacities of Some Oxygenated Hydrocarbons
Btu./lb.-mole • °F.

°F.	Formaldehyde	Acetaldehyde	Methanol	Ethanol	Ethylene Oxide	Ketene
32	8.281	12.39	10.27	16.72	10.74	10.93
60	8.331	12.61	10.42	16.99	10.92	11.10
77	8.358	12.73	10.52	17.16	11.08	11.18
100	8.406	12.90	10.63	17.38	11.30	11.31
200	8.623	13.62	11.16	18.33	12.24	11.82
300	8.873	14.35	11.68	19.26	13.16	12.38
400	9.145	15.08	12.22	20.16	14.06	12.89
500	9.430	15.78	12.72	21.03	14.92	13.37
600	9.720	16.47	13.22	21.87	15.74	13.81
700	10.008	17.13	13.71	22.66	16.54	14.23
800	10.293	17.76	14.18	23.44	17.28	14.62
900	10.571	18.36	14.63	24.16	17.96	14.98
1000	10.842	18.94	15.07	24.87	18.61	15.33
1100	11.105	19.49	15.50	25.52	19.22	15.66
1200	11.359	20.01	15.92	26.16	19.81	15.96
1300	11.603	20.50	16.32	26.77	20.38	16.26
1400	11.838			27.35		16.54
1500	12.063			27.92		16.80
1600	12.278			28.44		17.05
1700	12.484			28.96		17.29
1800	12.682			29.45		17.52
1900	12.871			29.91		17.74
2000	13.052			30.36		17.95
2100	13.226			30.79		18.15
2200	13.392			31.19		18.34

TABLE 13

Heat Capacity Equations for Some Oxygenated Hydrocarbons

Range: The equivalent of that indicated for the Centigrade Scale

Equation: $Cp^\circ = a + b(t) + c(t^2) + d(t^3)$

Units: cal./g-mole • °C. or °K.
Btu./lb.-mole • °F. or °R.

Compound	T	a	b.10²	c.10⁵	d.10⁹	Range	ERROR Max. Percent	ERROR Avg. Percent
Formaldehyde	°C	8.192	1.020	0.0000	−2.078	0–1200	1.41	0.62
	°K	5.447	0.9739	0.1703	−2.078			
	°F	8.020	0.5688	0.0034	−0.356			
	°R	5.477	0.5430	0.0526	−0.356			
Acetaldehyde	°C	12.37	2.798	−0.826	3.800	0–700	0.40	0.17
	°K	4.19	3.164	−0.515	3.800			
	°F	11.87	1.571	−0.249	−0.652			
	°R	4.19	1.758	−0.159	−0.652			
Methanol	°C	10.26	1.984	−0.448	1.92	0–700	0.18	0.08
	°K	4.55	2.186	−0.291	1.92			
	°F	9.91	1.111	−0.135	−0.329			
	°R	4.55	1.214	−0.090	−0.329			
Ethanol	°C	14.66	3.758	−2.091	4.740	0–1200	0.40	0.22
	°K	4.75	5.006	−2.479	4.790			
	°F	16.00	2.129	−0.653	8.128			
	°R	4.75	2.781	−0.765	8.128			
Ethylene Oxide	°C	10.61	3.690	−2.131	3.149	0–700	0.36	0.14
	°K	−1.12	4.925	−2.389	3.149			
	°F	9.95	2.092	−0.663	0.540			
	°R	−1.12	2.736	−0.737	0.540			
Ketene	°C	10.96	2.081	−1.447	4.22	0–1200	0.48	0.17
	°K	4.11	2.966	−1.793	4.22			
	°F	10.59	1.185	−0.4536	0.724			
	°R	4.11	1.648	−0.5536	0.724			

and temperature for each compound and to serve as a comparison of these relationships among the several compounds.

Tables 7, 8, 9, and 10 present, on all four temperature scales, the molal enthalpies relative to the icepoint (0° C. = 32° F.) which has been chosen the base temperature in each of this series of papers.

The mean molal heat capacities of these compounds have been calculated from the enthalpy data and are presented on the Centigrade and Fahrenheit scales in Tables 11 and 12. Of course the base temperature is again the icepoint (0° C. = 32° F.).

Since empirical equations for the heat capacities of compounds are often quite useful in thermodynamic calculations, there are presented in Table 13 sets of such equations for each of the compounds in this group. For each compound there are equations for use on any of the four temperature scales.

LITERATURE CITED

[1] Arnold, C. W., Progress Report for Celanese Fellowship in Chemical Physics at the University of Texas, January, 1950.

[2] Aston, J. G., Ind. Eng. Chem., **34**, 514 (1942).

[3] Beutnewitz, K. and Bonner, W., Physik. Chem., **B-39**, 126 (1938).

[4] Brickwedde, F. G., Moscow, M. and Aston, J. G., Bur. Standards J. Research **37**, 263 (1946).

[5] Coleman, C. F., and Deuries, T., J. Am. Chem. Soc., **71**, 2829 (1949).

[6] Deuries, T. and Collins, B. T., J. Am. Chem. Soc., **63**, 1343 (1941).

[7] Dixon, H. B., and Greenwood, G., Proc. Roy. Soc. (London), **A-105**, 199 (1924).

[8] Dubrats, C. J., Ind. Eng. Chem. **33**, 759 (1941).

[9] Drayton, G. J., and Thompson, H. W., J. Chem. Soc., **1948**, 1416.

[10] Glaque, W. F., and Gordon, W. F., J. Am. Chem. Soc., **71**, 2176 (1949).

[11] Godnev, I., and Morosov, V., J. Phys. Chem. (USSR), **22**, 801 (1948).

[12] Godnev, I., Pajuchina, A., and Swerdlin, A., J. Phys. Chem. (USSR), **14**, 374 (1940).

[13] Gunthard, H., and Heilbronner, E., Helv. Chim. Acta, **31**, 2128 (1948).

[14] Halverson, F., and Williams, V. Z., J. Chem. Phys., **15**, 552 (1947).

[15] Hurd, C. O., Personal Communication, November 20, 1947.

[16] Jatkar, S. K. K., J. Ind. Inst. Sci., **22**, 39 (1939).

[17] Ibid., p. 19.

[18] Kistiakowsky, G. B., and Rice, W. W., J. Chem. Phys., **8**, 610 (1940).

[19] Kobe, K. A., and Long, E. G., Petroleum Refiner, **28**, No. 2, 113, (1949).

[20] Ibid., **28**, No. 3, 125 (1949).

[21] Ibid., **28**, No. 5, 161 (1949).

[22] Ibid., **28**, No. 7, 145 (1949).

[23] Ibid., **28**, No. 10, 133 (1949).

[24] Ibid., **28**, No. 11, 127 (1949).

[25] Ibid., **29**, No. 1, 126 (1950).

[26] Ibid., **29**, No. 2, 124 (1950).

[27] Ibid., **29**, No. 3, 157 (1950).

[28] Ibid., **29**, No. 5, 89 (1950).

[29] Kobe, K. A., and Pennington, R. E., Petroleum Refiner, **29**, No. 7, 129 (1950).

[30] Matsen, F. A., and Hamner, W. F., Progress Report for Celanese Fellowship in Chemical Physics at the University of Texas, December, (1948).

[31] Morris, J. C., J. Chem. Phys., **11**, 230 (1947).

[32] Pitzer, K. S., and Weltner, W., J. Am. Chem. Soc., **71**, 2842 (1949).

[33] Regnault, M. V., Ann. Chim. Phys., **24**, 342, (1871).

[34] Shaha, A. K., Indian J. Phys., **6**, 445 (1931).

[35] Smith, J. M., Trans. Am. Inst. Chem. Eng., **42**, 983 (1946).

[36] Ibid., Chem. Eng. Progress, **44**, 521 (1948).

[37] Stevens, E. H., Ann. Physik, **7**, 285 (1902).

[38] Stevenson, D. P., and Beach, J. Y., J. Chem. Phys. **6**, 25, 108, 341 (1938).

[39] Thibaut, F., Ann. Physik, **35**, 347 (1911).

[40] Thompson, H. W., Trans. Faraday Soc., **37**, 251 (1941).

[41] Thompson, H. W., and Harris, G. P., Trans. Faraday Soc., **38**, 37 (1942).

Figure 1. M/P Control Station (size 4⅛ x 4¾ inches). The center pointer always indicates the value of the process variable. The small pointer—which operates at the periphery of the dial—indicates: either 1) the control-point setting, or 2) the valve pressure.

THE "GRAPHIC PANEL" system of instrumentation, long known but little used until the past year or so, is finding increased application in process plants. The reasons behind this trend include operating and investment factors and the development of adequate compact instruments that can be mounted upon a graphic panel of convenient size. Many new installations are under construction. In July, 1950, plants on stream utilizing graphic panel control include the following:

Continental Oil Company, Denver, Colo., Thermofor catalytic cracking unit (Lummus), 4800 barrels per day.

Cosden Petroleum Corporation, Big Spring, Texas, Fluid catalytic cracking unit (UOP), 6000 barrels per day.

Deep Rock Oil Company, Cushing, Okla., Fluid catalytic cracking unit (UOP), 5000 barrels per day.

Globe Oil and Refining Company, Lemont, Ill., Fluid catalytic cracking unit (UOP), 6000 barrels per day.

Old Dutch Refining Company, Muskegon, Mich., Platformer (UOP), 1500 barrels per day.

Rock Island Refining Company, Indianapolis, Ind., Complete refinery, including Fluid catalytic cracking unit (UOP), 10,000 barrels per day.

The Standard Oil Company (Ohio), Lima, Ohio, Vacuum unit (Lummus), 9000 barrels per day.

The Standard Oil Company (Ohio), Lima, Ohio, Furfural unit (Lummus), 20,000 barrels per day.

Wood River Oil & Refining Company, Hartford, Ill., Fluid catalytic cracking unit (UOP), 7500 barrels per day.

Graphic Panels in Operation

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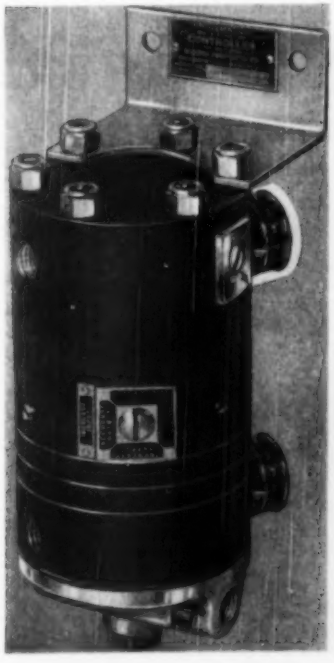
THE casual observer is impressed by the attractive appearance of the graphic control panel. He may be surprised, however, to find that it is often less expensive to install a graphic panel than to install a conventional panel. On the other hand, refinery men soon learn that the operational advantages provided by graphic-panel instrumentation are the underlying reasons for the growing acceptance of these panels.



The idea of a "graphic" or "picture" control board is not new. In its more elementary forms, the idea has been present in the electric-power field and in the oil-refining industry for eight or more years. The early "picture" panels were simple flow diagrams, with practically all the instruments located at one side of the picture. Until two years ago, further development was retarded by the lack of control instruments small enough for mounting within the flow diagram. These new small instruments (4⅛-inches x 4¾-inches) enabled the panel designer to locate the control instruments for the process variables at their corresponding points in the flow diagram.

In September, 1948, the M/P (miniature-panel) control station, shown in Figure 1, was developed for use in conjunction with the remote-set pneumatic controller, shown in Figure 2.

Figure 2. Remote-Set Controller (size 8¾ x 3⅛ inches diameter). This instrument operates on a balance of air pressures, without the use of levers or linkages. The two needle valves provide adjustment of the throttling range and reset rate.

With this combination, the graphic panel of today—with all its operational advantages—has materialized.

For a number of years, the trend in refinery engineering has been to build units with small storage capacities between stages, but with greater and greater thruputs. This type of unit, however, reduces the time during which an operator can recognize an undesirable process condition that is developing and can correct the condition before a minor upset becomes a major shut-down. These units require measuring and controlling instruments that are both fast and reliable. The graphic control panel and its field-mounted components provide this type of control.

Part of the widespread interest and acceptance of the graphic control board results from advantages other than operational. The control room for a modern, compact graphic panel can be much smaller and less expensive than the control room for a conventional panel. For example, the cost of the graphic-panel control room at The Standard Oil (Ohio) refinery was only one-third as much as the estimated cost for a control room housing a conventional panel. Other advantages

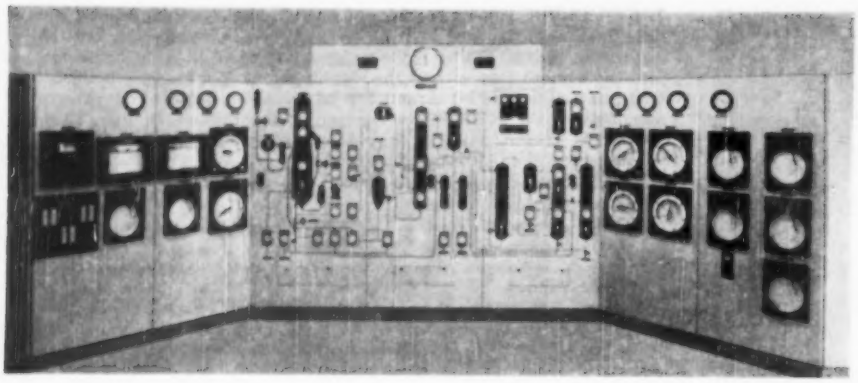


Figure 3. At Globe Oil and Refining Company Plant. This typical example of a modern graphic panel is used to control a 6000-barrel-day UOP Fluid catalytic cracking unit.

of graphic panels include a reduction in the cost of the instruments themselves, the interchangeability of instruments, and the ease and economy of installing a prefabricated control board.

A typical example of a graphic panel is shown in Figure 3—the entire control board of the Fluid catalytic cracking unit at Globe Oil and Refining Company. This photograph was taken soon after the unit was put "on stream." The operator can follow the values of all important process variables because he can read all the M/P control stations at a glance. He can alter the control point of any variable at will, and he can watch the effect on the preceding and succeeding variables. He can quickly trace any process instability to its source. At any time, without disturbing the process, he can check the pressure on the diaphragm control valve by merely moving a switch. He can transfer from automatic control to manual control, and back again, without upsetting the process.

The most critical process temperatures are indicated and controlled from the M/P stations on the graphic panel. On the Globe Refinery panel, temperatures of secondary importance are indicated on an electronic potentiometer-pyrometer, with a 36-point switching assembly. Small numbers are usually placed on the flow diagram, at points corresponding to the actual location of the thermocouples in the process. Thus, the location of each thermocouple is readily apparent from the numbering system.

The liquid levels in the process equipment are clearly indicated on the corresponding graphic symbols. The level indicators simulate the actual levels in the process vessels by means of an illuminated colored plate. This plate is positioned by the output of

Figure 4. At Rock Island Refining Company plant. This shows the back of the graphic panel (gas-concentration section).

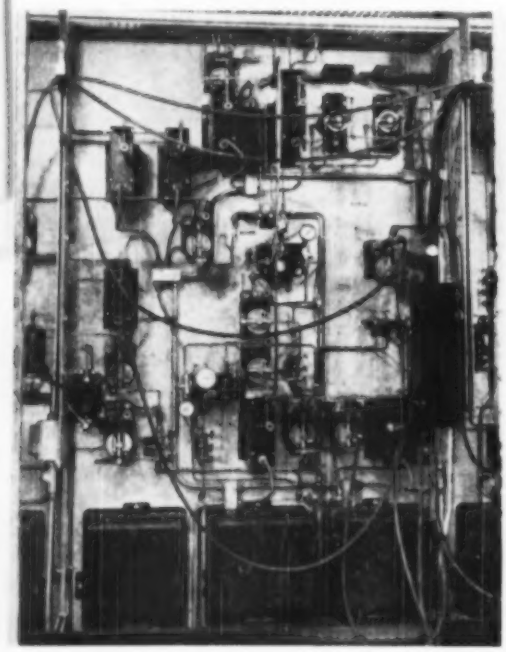
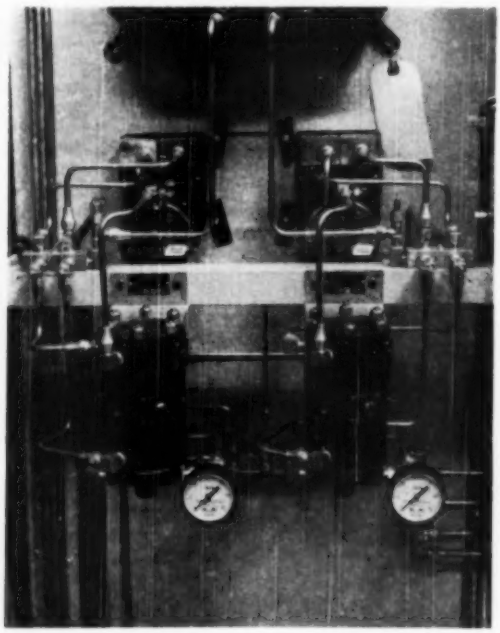


Figure 6. The photograph below shows two M/P stations and controllers, as seen from the rear of the panel.



the pneumatic transmitter measuring the actual liquid level. The positions of the two large slide valves in the reactor-regenerator unit are also indicated by means of similar equipment.

Visible and auditory alarms are provided to alert the operator when critical process variables deviate beyond desired limits. The auditory alarm may be reset immediately by the operator, but the visible alarm (located at the proper place in the graphic flow diagram) remains lighted until the problem is corrected. If a second critical variable deviates beyond its limit, another visible alarm will be initiated; and the auditory alarm will sound again, calling the operator's attention to the new complication.

On each wing of the Globe Refinery panel, there are multi-pen recorders which make a record of those process variables useful for operational and accounting purposes.

Special interlocking instrument arrangements can be made more compact and less complicated when graphic-panel instrumentation is used, instead of conventional instrumentation. Let us consider the graphic panel (shown in Figure 3) controlling a fluid catalytic cracking unit. Special instrument arrangements have been used to obtain optimum automatic control, as well as to increase safety. For example, with a controlled flow of raw oil into the reactor, the conversion of charge stock is dependent on the depth of catalyst in the reactor. The level of the catalyst is determined by a pneumatic level controller, which positions a large slide valve in the line carrying the spent catalyst to the regenerator.

Under normal operating conditions, with flow in the proper direction, there is a differential pressure of about 5 or 6 psi across the spent-catalyst slide valve. A serious process upset, or equipment failure, could reverse this flow and shut down the entire catalytic cracking unit. To prevent such an occurrence, an interlocking instrument arrangement is used. The differential pressure across the slide valve is indicated continuously on an M/P station at the control panel. The control point of an on-off pneumatic controller is set at a safe value (approximately) 3 psi. differential pressure). When the differential pressure is above the control-point setting, the on-off controller applies full output air pressure to the air-supply connection of the reactor-level controller. With full air-supply pressure, the level controller functions without interference. If the differential pressure drops below the control-point setting, the on-off controller cuts off the air supply to the level controller. When this air supply is zero, the pneumatic output of the level controller also becomes zero, and the spent-catalyst slide valve is shut, in order to prevent a reversal of flow which might damage the unit.

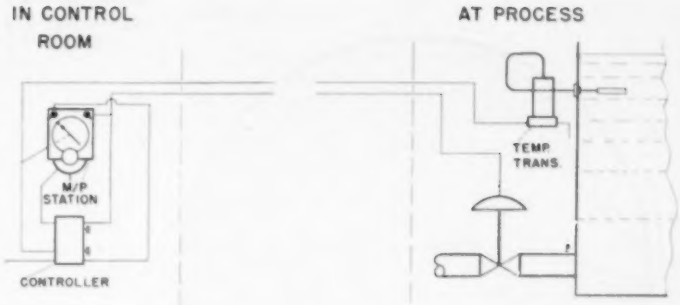


Figure 5. Control Circuit for a Temperature Application

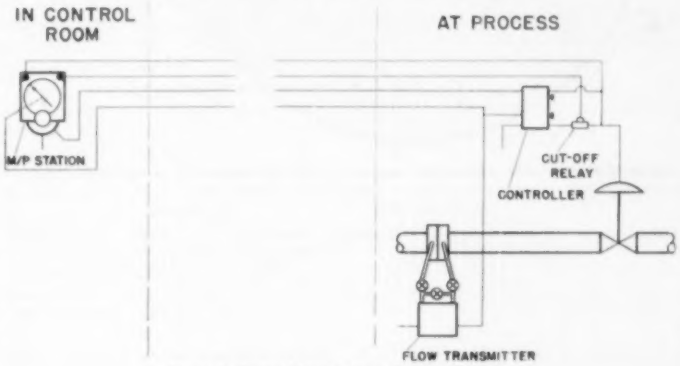


Figure 7. Control Circuit for a Flow Application

The air supply for the pressure regulator on the M/P station is supervised in the same manner, so that even when the slide valve is manually loaded, the same safety feature is present.

The temperature in the reactor is determined by a pneumatic controller which positions the slide valve in the line carrying regenerated fluid-catalyst to the reactor. The flow through this regenerated-catalyst slide valve cannot be reversed, because it has the same "override" protection as the spent-catalyst slide valve.

Whenever the differential pressure across either slide valve drops below a desired value, an alarm is sounded and a red light on the graphic panel draws the operator's attention to the proper slide valve. This ease and speed of locating an undesirable process condition is not present on most conventional panels, where a row of red lights, side by side, indicates trouble at numerous points in the system.

Figure 4 is a view from behind the

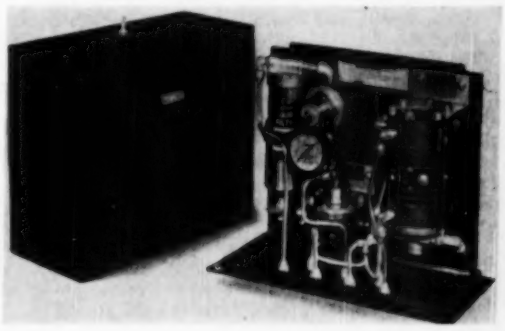


Figure 8. For installation at the process, the remote-set controller, with a cut-off relay and air set, is often mounted in a weatherproof housing.

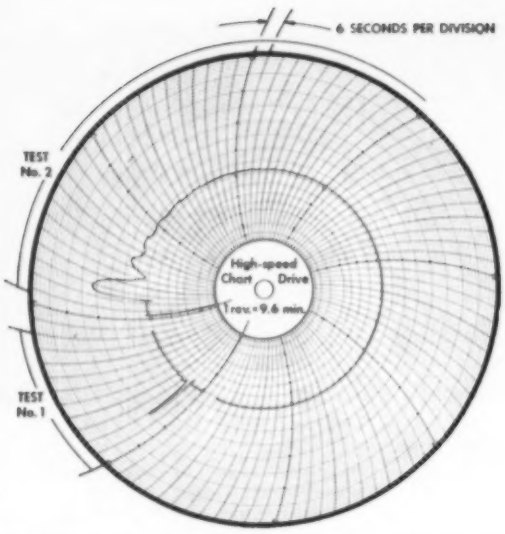


Figure 9. Note data in table below.

FLOW CONTROL TESTS—Controller Located: 1) At the Process, 2) In the Control Room

Test	LOCATION OF		SETTINGS		Recovery Time
	Controller	M/P Station	Throttling	Reset	
1	Field	Panel	90%	0.03 minutes/repeat	12 sec.
2	Panel	Panel	150%	0.5 minutes/repeat	200 sec.

Optimum controller settings were used in both tests. Permanent load upsets were 15 percent of flow.

graphic panel at the Rock Island Refinery. This installation employs an unusual method of obtaining the necessary records. Rubber hoses and snap fittings are used for connecting any process variable to a recorder, located on an accessory panel. These connections are transferred easily and quickly, as operating conditions change or as different variables become of interest.

The large square cases along the bottom of the panel are circular-chart pneumatic transmitter-recorders, which receive an electric impulse from a thermocouple out in the field. These instruments record the temperature and transmit an air pressure which is proportional to the temperature. This air pressure is received by an M/P station and its controller on the panel board—thus indicating and controlling that process temperature.

The smaller rectangular boxes, with both pneumatic and electrical connections (four of which are located at the top of the panel in the left-hand corner), are used for showing the liquid level in important process vessels. These level indicators are the same as those used on the Globe Oil Refinery panel (Figure 3).

Two basic types of control circuits are used with modern graphic panels—the choice depends primarily upon the rate at which the process variable can change. Process variables with long time-constants use controllers mounted on the panel board, while those with short time-constants use controllers mounted at the process, to overcome transmission time-lags.

Temperature, liquid level, and pressure are examples of process variables that are characterized by long time-constants; therefore, transmission time-lags are usually unimportant. Figure 5 is a schematic diagram of the entire control circuit for a typical temperature application. Figure 6 shows a close-up of two M/P stations and their panel-mounted controllers.

When the process variable has a short time-constant, however, as in the case of flow, the transmission time-lag becomes all-important for optimum control. Figure 7 is the schematic diagram of a typical flow-control application. Transmission time-lags are eliminated by having the complete control loop at the process, with the control supervised from the M/P station on the graphic panel. With the controller mounted at the process, a pneumatic cut-off relay automatically seals off the output of the controller to the valve, when the operator desires to load the valve manually. Figure 8 shows the controller, pneumatic cut-off relay, and air supply set—all enclosed in a weatherproof housing for mounting at the process.

Reliable field data indicate that pneumatic controllers—mounted at the process, instead of in the control room—can use narrower throttling ranges and faster reset rates (at least five times as fast). In general, narrower throttling ranges and faster reset rates mean better control, with less deviation from the control point after a load change. When the controller is mounted at the process, a very wide range of throttling and reset rates can be used. In contrast, these settings are usually critical when flow controllers are mounted at a distance from the process.

The recorder chart in Figure 9 (made with a special high-speed chart drive) shows the result of tests on a liquid-flow application. These records illustrate the improvement which results from locating the controller at the process, instead of on a control board 600 feet away. On flow applications, experience has shown that significant improvement results, even if the control board is only 50 feet from the process. For these tests, all transmission lines were $\frac{1}{4}$-inch tubing. A conventional thin-plate orifice and a bellows-type differential-pressure transmitter were used. This flow transmitter did not use mercury and was without any damping action.

In brief, the principal advantages of graphic panel instrumentation are as follows:

1) The operator can see at a glance all the important process variables and their relationship to each other. At the M/P station, he can make all the possible control changes that he desires—and, at the same time, he can see the effect of each change on the other process variables. He can often tell when an equipment breakdown is developing—and, therefore, he can take steps to prevent a complete shut-down.

2) Refinery managers and superintendents (who see the control board only periodically) can easily follow the graphic flow sheet and can quickly tell how the refinery is operating.

3) New operators can understand the entire process in less time, because the panel is like a working model. Symbols and color-coding make certain the identification of instruments and process equipment.

4) The control room for a modern, compact graphic panel can be much smaller and less expensive than the control room for a conventional panel.

5) The remote-set controllers, supervised from the graphic panel, provide improved flow control, which benefits the entire process.

Expansion of "L" Type Bends

F. E. WOLOSEWICK
Sargent and Lundy, Engineers, Chicago

THE SIMPLEST of pipe bends, the "L" type, is also the most important means available to the designer who must provide for the thermal expansions of process equipment and piping that operates at temperatures either above or below atmospheric. Good layout using this bend as a principal component can produce process units that approach the minimum both of piping and of expansion problems. This article deals with the methods used in calculating such bends.

THE "L" type bend, often called right-angle bend, is one of common occurrence. Its application is not only relegated to pipes lying in a horizontal plane, but is often used in making connection with vertical vessels. Under such conditions the vertical expansions of the vessel may cancel some of the expansion of the line.

On the other hand, if the line is cold, as with a reflux line, expansion of the vessel will place strains on the line. Under conditions of unbalanced differential expansions either horizontally or vertically, the problem of determining the equilibriating forces and stresses can become involved. This is especially true when number of similar shapes must be analyzed, each differing by some substantial increment.

In order to reduce the analysis of such bends to a minimum, use can be made of the charts shown in Figure 1. (See next page.)

In preparing these charts, right-angle pipe connections were assumed. This was done to simplify resulting mathematical expressions. In order to take cognizance of the effect of radius, and differential expansions, extremely cumbersome and complicated charts would be required. Fortunately such refinements are unwarranted, except in the extreme cases, where experience dictates that more precise analysis would be required.

From the writer's past experience, it has been found that with a radius of bend of five pipe diameters, and lengths on each side of bend of 20 to 25 pipe diameters, excellent results were obtained through use of charts shown in Figure 1. In many instances these distances could be decreased to 15 times pipe diameters without materially affecting equilibriating forces and moments from those determined from equations listed in this article.

When weld ells are used, equilibriating forces and moments when determined from Figure 1, will generally be higher. This is due to the fact that weld-ells possess considerable amounts of flexibility. However when the lengths on each side of ell are 25 or or more pipe diameters, flexibility of weld ells may be ignored. In general then, equilibriating forces due to expansions as determined from Figure 1, will generally be lower when five diameter bends are used, and somewhat higher when weld ells are used. For a quick analysis, the chart gives satisfactory results.

When using graphs it is necessary to determine two relationships, namely, the ratio of the two expansions, and the ratio of the two sides. With these values known, moments and direct forces can be determined readily. Since the lines in the charts are straight, any relationship of the variables beyond the range of values, indicated can be determined readily, by extension of these lines.

As an illustrative example, consider flexure of six-inch, Schedule 80 pipe, where lengths "b" and "a" are respectively 200, and 100 inches. Modulus of elasticity is 22.5×10^{-6}, expansion "b" is 0.5 inches, expansion "a" = 1.00 inches. The ratio of "b/a" = 2, while the ratio of the two displacements, is also equal to 2. Moment of inertia of the bend is 40.5 inches fourth.

From Figure 1, multiplier for M_{AB} is 0.589, for M_{BA} multiplier is 0.665, and for M_{CB}, 0.834. For direct forces H, and V, the coefficient are 1.52, and

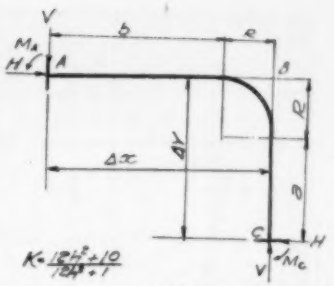


FIGURE 2

0.625. The equilibriating forces and moments can be determined as follows:

$$M_{AB} = \frac{6 \times 22{,}500{,}000 \times 40.5}{10.000} \times 0.589 = 323{,}000 \text{ inch pounds}$$

$$M_{BA} = \frac{6 \times 22{,}500{,}000 \times 40.5}{10.000} \times 0.665 = 364{,}000 \text{ inch pounds}$$

$$M_{CB} = \frac{6 \times 22{,}500{,}000 \times 40.5}{10.000} \times 0.834 = 457{,}000 \text{ inch pounds}$$

$$H = \frac{6 \times 22{,}500{,}000 \times 40.5}{1{,}000{,}000} \times 1.52 = 8300 \text{ pounds}$$

$$V = \frac{6 \times 22{,}500{,}000 \times 40.5}{1{,}000{,}000} \times 0.625 = 3400 \text{ pounds}$$

When more precise values are desired for moments and direct forces, the equations listed below may be used. Figure 2 gives the necessary dimensions.

(1) $$M_c = H(KR^2 + \frac{a^2}{2} + ab + Rb + 1.57KaR) - V(Rb + \frac{b^2}{2} + 1.57KR^2)$$
$$a + b + 1.57KR$$

(2) $$E\Sigma\Delta Y = M_c(0.57KR^2 + Rb + \frac{b^2}{2}) - H(0.57KaR^2 + \frac{KR^3}{2} + abR + \frac{ab^2}{2} + R^2b + \frac{Rb^2}{2}) + V(0.36KR^3 + R^2b + Rb^2 + \frac{b^3}{3})$$

(3) $$EI\Delta X = -M_c(\frac{a^2}{2} + 1.57KRa + KR^2 + ab + Rb) + H(\frac{a^3}{3} + 1.57KRa^2 + 2KR^2a + 0.785KR^3 + a^2b + R^2b + 2abR) - V(0.57KaR^2 + \frac{KR^3}{2} + abR + bR^2 + \frac{ab^2}{2} + \frac{Rb^2}{2})$$

It will be observed that in order to determine the necessary values, a simultaneous solution of three equations is necessary. It is necessary to maintain consistent units when using the above equations. Thus if the values for "a" and "b" are expressed in feet, then E, I and expansions "x" and "y" must also be expressed in foot pounds, feet to the fourth, and in feet respectively.

The value of K in the above equations is the flexibility constant for bends and is shown in Figure 2.

(Note Figure 1 on following page)

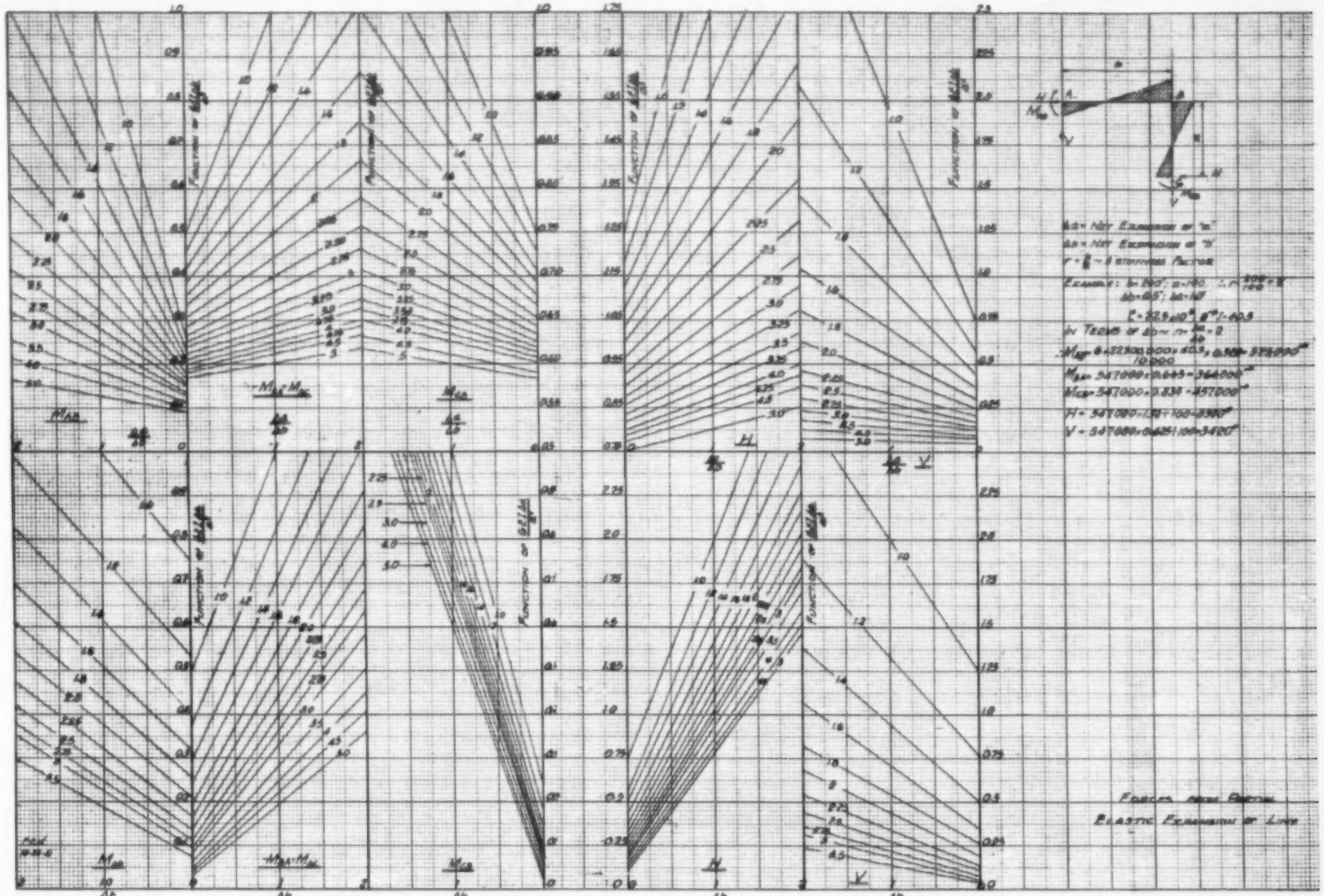
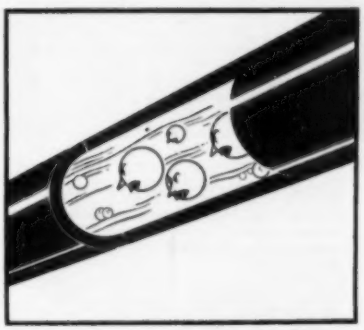


FIGURE 1

BUSINESS IN MOTION

To our Colleagues in American Business . . .

● Quite a number of years ago Revere coined the phrase "Bubbles have teeth." This refers to the fact that what is called air entrainment is highly damaging to condenser tubes. Bubbles carried along with the cooling water set up a strong disturbance in it, disrupting the film that should protect the metal, and actually seeming to eat away the tube. The oxygen contained in the air bubbles also is destructive. Fortunately, the effects of air entrainment on condenser tubes are sufficiently distinctive to permit Revere Research to detect the trouble by examination of short lengths cut from tubes that have failed before their time.



Thus it happens that every once in a while the Research Department in Rome, New York, working through the Technical Advisory Service, is able to say that there is air leaking into a condenser it has never seen, in a far-off state. The problem then is to seal the water system against the entrance of air. This is not always an easy task, and it is one that the Revere Technical Advisory Service is glad to tackle together with the customer if asked to do so. After all, we want our condenser tubes to last as long as possible; that's what makes customers happy, and builds and preserves our reputation as producers of fine tubes.

In one such instance of bubble trouble, the operator, a public utility, could find no visible sign of a leak. Checking and tightening every bolt and seal produced no results. Finally it was decided to put plate glass windows in some of the inspection plates, in order to see what was going on inside. This located the defect, a stream of bubbles being easily seen pouring out of a gasket. The water was flowing past that gasket with sufficient velocity to suck air in, and was moving too fast to leak out.

In another instance, a few samples of failed tubes from an oil refinery (located almost 3,000 miles away from the utility) were sent to Revere's Research Department. The refiner was told that his trouble was due to bubbles. Again, a check of the condenser showed nothing. The water inlet and outlet lines and all gaskets and bolts seemed to be perfectly tight. Here was another puzzler. But once again it seemed plausible to assume that air was being drawn in where water velocity was high enough to create a suction. The search finally went all the way back to the water pumping station, where two cracked castings were located. Air sucked in through two tiny cracks was enough to do a lot of damage; bubbles do indeed have teeth.

You can see that Revere wants its customers to be satisfied, and to that end sometimes goes to great lengths to look into conditions for which it may be in no way responsible. This attitude is typical of American business; every company rightly regards the satisfied customer as a precious asset, the source of orders that support the business and its employees. Therefore it is suggested that if any product you buy for use in your business is not completely satisfactory, let the supplier know, even if you are sure the trouble is not his fault. He will be glad to cooperate with you in a search for satisfaction.

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The MONTH... in the INDUSTRY

Cities Service Refining Division Headed by Haugen

Lee N. Haugen succeeded H. W. Camp, as manager of the refining division, of Cities Service Oil Co. (Delaware), on September 1, at which time Camp retired. Haugen, who has been general superintendent since 1947, has been employed by Cities Service 27 years.

Haugen

Following his graduation from Iowa State College with a degree in chemical engineering, Haugen was associated with Cities Service as a junior engineer, refinery cost engineer, general foreman at the Ponca City, Okla., refinery and superintendent. Haugen was manager of the East Chicago, Ind., refinery from 1942 to 1947.

He is a member of the API, Phi Lambda Upsilon, honorary chemical fraternity, and past president of the East Chicago Rotary club.

Oil Companies Announce Wartime Employe Benefits

Standard Oil Company of California, Shell Oil Company, and Standard Oil Company (New Jersey) are among the companies which have announced programs of individual benefits and dependent's allowances for employes entering active military service.

Under Standard of California's plan, employes with one year service will receive an adjustment allowance of one month's regular pay, with Jersey Standard and Shell one-year employes, receiving payment equal to two month's salary.

The dependent's allowance will be the difference between employe's regular pay and government base pay, with the monthly allowance limited to 50 percent of employe's normal company salary.

Also included in the programs are provisions for the old age pension plan, group insurance, survivor benefits, and retirement funds. The Standard of California and Shell programs were retroactive July 1, 1950, and are more liberal than those in effect during World War II.

Government Orders Boost In Butyl Rubber Output

Reopening of the third and last unit of government-owned Butyl rubber plant operated at Baton Rouge, La. by Esso Standard Oil Company has been ordered by RFC's office of rubber reserve. The company said this will increase output of the plant to full capacity of 42,000 long tons per year. The third unit will be ready for operation in about five months.

Radium Used by Sun To Measure Catalyst

Completion of successful commercial tests on instruments utilizing radium and Geiger counters for the measurement of hot catalyst in an oil cracking process was announced last month by Sun Oil Company.

The method can be applied in any industry where the level of either dry or liquid material must be measured, Clarence H. Thayer, vice president of manufacturing, said.

In the oil cracking plant, the catalyst flows at a rate of 200 tons per hour through large thick-walled steel vessels atop towers as high as 300 feet at Sun's Toledo, Ohio, refinery. Precise measurement of the level of catalyst in the vessels is essential to proper operation of the process. Because of the heat—about 1100°F.—and the presence of swirling, abrasive dust inside the vessels, mechanical measuring devices are impractical.

Sun's development is based on the knowledge that a given quantity of radium sends out a given number of gamma rays per second, and that the distance they travel depends upon the density of the material they must penetrate. The precise tendency of certain thicknesses of catalyst, steel, insulation and oil vapor to absorb gamma rays, and the exact amount of radium required for measurements over the range of distance necessary had to be determined.

In operation, the radium and Geiger counters are placed on opposite sides, or ends, of the vessels. The level of contents is measured by the number of atomic impulses per second which penetrate through to the counters. Measurements are made continuously in this way, and are recorded in the control room of the plant.

Four of the ten Sun instruments measure and record the rise and fall of catalyst level over a distance of 35 feet, four others over 8 feet, and two over 18 feet.

Thayer said an improved type of Geiger counter and amplifier developed by Instruments, Inc., of Tulsa, Oklahoma, is used in the Sun installation.

Possible uses of this new system of measuring levels are almost unlimited, Thayer said. For example, it could be used to determine variations in tide levels in large rivers, fluctuations in levels in grain elevators, milk in tanks, coal in bunkers, etc.

This development was accomplished under the direction of Edward J. Grace, instrument consultant of Sun Oil Company.

Stanolind Senior Engineer

William H. Wheatley has been promoted from inspection supervisor to senior mechanical engineer in the manufacturing department, Standolind Oil and Gas Company, Tulsa. Wheatley received his bachelors degree in petroleum engineering in 1939 from the University of Oklahoma. He joined Stanolind in 1946.

Above is one of the designs used by the Oil Industry Information Committee to promote and popularize Oil Progress Week of 1950, October 15-21.

Socony British Subsidiary To Build Thames Refinery

Vacuum Oil Company, a British subsidiary of Socony-Vacuum Oil Company, Inc., has taken over a site on the Thames Estuary for a $28-million oil refinery with a capacity of approximately 17,500 barrels daily. Plans for the refinery, which will treat mainly crude oil from the Middle East, have been agreed to by the British government which is providing some of the money for the construction program. The plant is estimated to take three years to complete.

The British Powell-Duffryn Company sold its oil storage and blending plant at Coryton, on the Thames, last March to Vacuum Oil in return for a half interest in the latter.

American Chemists Create High Polymer Division

Professor Carl Shipp Marvel of the University of Illinois and former president of ACS, has been elected first chairman of a newly created division of high polymer chemistry, American Chemical Society. Professor Herman F. Mark, director of the Polymer Research Institute at the Polytechnic Institute of Brooklyn, is secretary of the division.

The new division held its initial sessions in Chicago September 4-6 during the society's 118th national meeting.

Texas A & M Symposium On Process Instrumentation

"Instrumentation for the Process Industries," fifth annual symposium, to be held October 11-13, at Texas A. & M. College Station, will include talks on continuous analysis, graphic panels, improved pneumatic control system, developments in electronic instrumentation, including process control; instrumentation of an ammonia plant; power plant control; speed control and synchroniza-

PENBERTHY PRODUCTS THAT improve PROCESS AND PLANT

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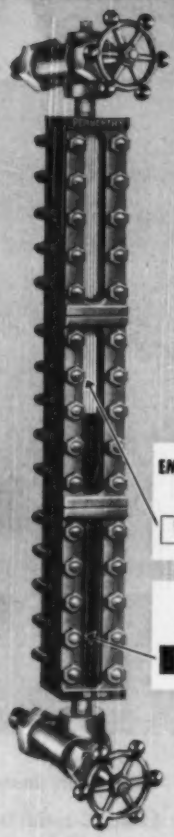

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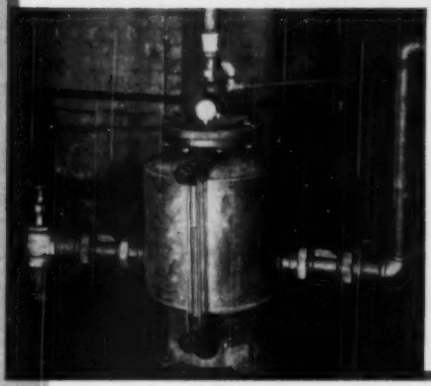

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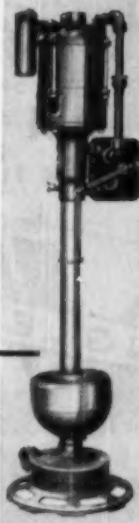
PENBERTHY *Explosion Proof* SUMP PUMPS



Motor and switch totally enclosed, this pump has Underwriters approval for Class I, Group D, and Class II, Groups E, F and G hazardous locations. These include gasoline, solvent vapors, metal dust, natural gas, carbon black, naphtha, alcohol, grain dust, acetone, lacquer, coal and coke dust, etc. Made of copper and bronze throughout, this pump is corrosion proof, durable, thoroughly dependable. Write for Bulletin 4929.

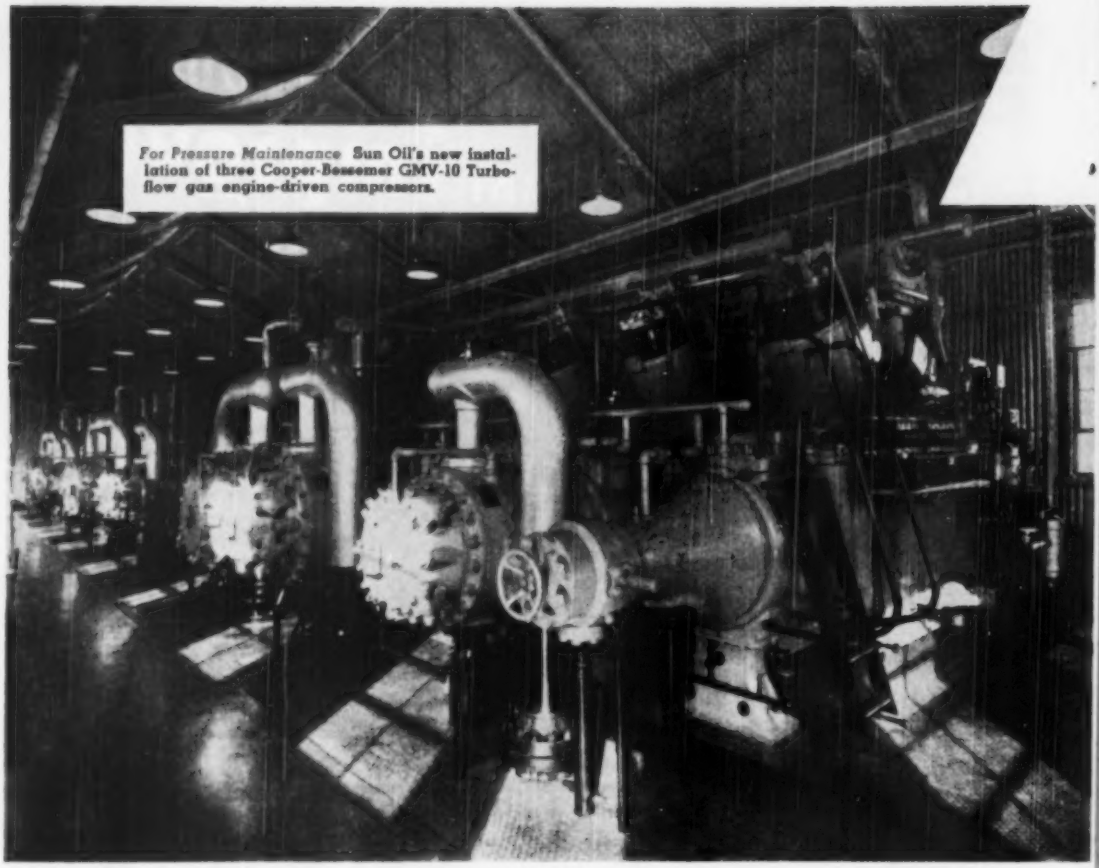
PENBERTHY ALSO MANUFACTURES A COMPLETE LINE OF LIQUID LEVEL GAGES IN BRONZE, IRON, STEEL AND ALLOYS

PENBERTHY INJECTOR COMPANY

DETROIT 2, MICHIGAN

Established 1886 — *Canadian Plant, Windsor, Ontario*

4290



For Pressure Maintenance Sun Oil's new installation of three Cooper-Bessemer GMV-10 Turboflow gas engine-driven compressors.

On the job

for the SUN OIL COMPANY

AT JAMESON FIELD, WEST TEXAS

Sun Oil's new field plant makes available about 8,000,000 cubic feet of high pressure gas for return to the oil producing horizon . . . and recovers up to 30,000 gallons of natural gasoline and butane-propane fractions daily.

Here, in this modern plant, Cooper-Bessemer units team up for highly

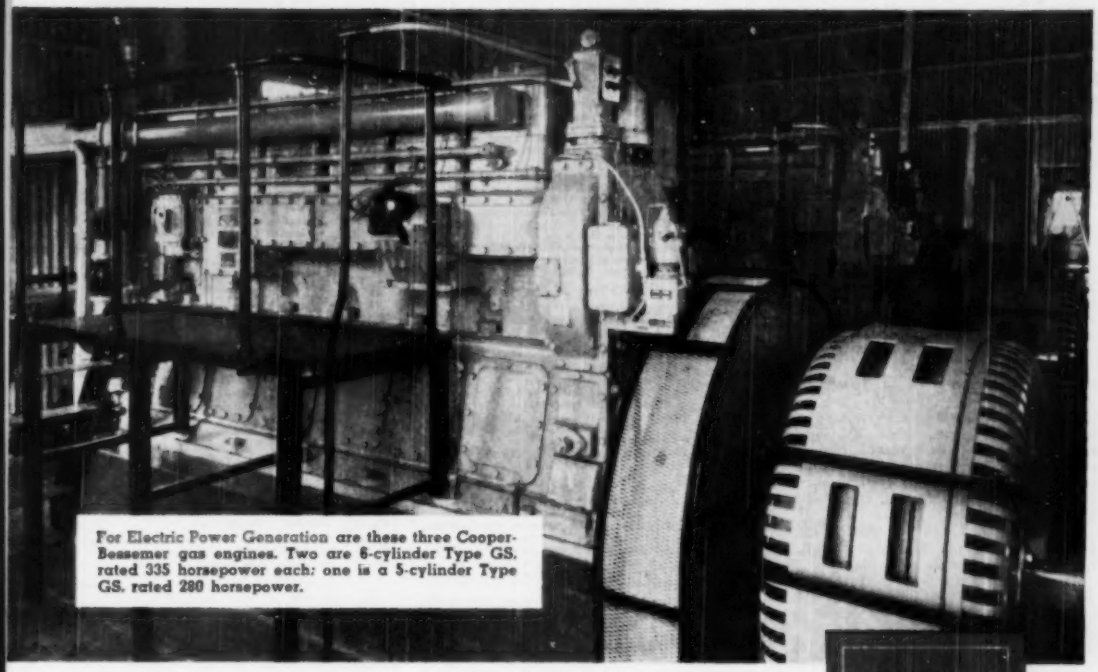
V ANGLE

Compressors

New York Washington Bradford, Pa. Parkersburg, W. Va. San Francisco, Cal. Seattle, Wash.

PARTNERS PULL TOGETHER

For Dependable Low Cost Operation



For Electric Power Generation are these three Cooper-Bessemer gas engines. Two are 6-cylinder Type GS, rated 335 horsepower each; one is a 5-cylinder Type GS, rated 280 horsepower.

efficient performance — three 1,100 hp GMV Turboflow gas engine-driven compressors and three type GS gas engines driving generators.

The selection of Cooper-Bessemer Turboflow engines and compressors means a saving of up to 25% in space, in foundation, in cooling equipment and in fuel consumption compared with engines of equal displacement.

When your plans call for compressors or power for pumps or electric power generation, check first with Cooper-Bessemer. Remember there's a complete line of Cooper-Bessemer V-angle compressors — GMX, GMV, and GMW units ranging in size from 200 to 2500 horsepower.

Another Example of Efficient Power at Lower Cost

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Houston, Dallas, Greggton, Pampa and Odessa, Texas Tulsa Shreveport St. Louis Los Angeles

The MONTH...

tion of multi-unit gas or diesel engine plants; and unbalanced values acting on control valve plugs and their influence on diaphragm motor design.

To register by mail, send $6.00 check (payable to A. & M. College of Texas) to P. G. Murdoch, chemical engineering department, A. & M. College, College Station, Texas, along with name, company affiliation, and whether you will attend the banquet and social evening.

Research Workers Get New Standard of Indiana Posts

Adams

Thiele

Standard Oil Company (Indiana) has made E. W. Thiele and E. W. Adams associate directors of research, and eight others have been named to the newly created position of division director. The title of assistant director of research was abolished.

Dr. Thiele received his undergraduate training at Loyola (Chicago) and the University of Illinois, and his Sc.D. degree from Massachusetts Institute of Technology, in 1925. He joined Standard's research staff in the same year, and became assistant director of research in 1935.

Dr. Adams received his B.S. degree from the University of Illinois, and did graduate work at Illinois, Iowa State, and Wisconsin, receiving his Ph.D. degree from Wisconsin in 1924. He joined Standard the following year and became assistant director of research in 1945.

The eight division directors: A. L. Conn, pilot plants; J. B. Duckworth, automotive research; Nathan Fragen, all research activities in the field of chemical products; C. M. Loane, research on lubricants; J. E. Seebold, process design and economics; B. H. Shoemaker, exploratory studies in connection with the company's major products; E. B. Tucker, analytical research; P. C. White, research on fuels and special products.

R. C. Mallatt was made chief chemist of the Whiting refinery. Newly appointed section leaders are H. R. Taliaferro, L. W. Mixon, and W. R. Hertwig. New group leaders are R. W. Watson, C. W. Brackin, and R. L. Yahnke.

Esso Reserve Unit Alerted

The first of several defense service units sponsored by Esso Standard Oil Company has been alerted for mobilization. The unit is the 643rd quartermaster petroleum depot company, U. S. Army Reserve and presently is composed of employes from Esso's Pennsylvania division. It will be responsible for the operation of petroleum depots, tank farms and pipe line terminals supporting combat units.

THE OIL MAN'S CALENDAR

1950	
SEPT.	
11–15	**American Society of Mechanical Engineers, Industrial Instruments and Regulators Conference with the Instrument Society of America, Buffalo, N. Y., Municipal Auditorium.**
13–15	**National Petroleum Association, Atlantic City, N. J., Hotel Traymore.**
18–22	**Instrument Society of America, Fifth National Conference and Exhibit, Buffalo, N. Y., Memorial Auditorium.**
25–27	**American Society of Mechanical Engineers, Petroleum Mechanical Engineering Division, New Orleans, The Roosevelt.**
OCT.	
1– 3	**Independent Petroleum Assn. of America, Annual Meeting, St. Louis.**
2– 6	**American Gas Association Annual Convention, Atlantic City, N.J.**
16–20	**National Safety Congress, National Safety Council Exposition, Chicago.**
15–21	**Oil Progress Week.**
27	**Natural Gasoline Association of America, Southern Regional Meeting, Tyler, Texas, Blackstone Hotel.**
30 to Nov. 1	**National Lubricating Grease Institute, Annual Meeting, Chicago, Edgewater Beach Hotel.**
NOV.	
2– 3	**Eighth Annual Pittsburgh Conference on X-Ray and Electron Diffraction, Pittsburgh, Mellon Institute for Industrial Research.**
2– 3	**Society of Automotive Engineers, Diesel Engine Meeting, Chicago, Hotel Knickerbocker.**
9–10	**Society of Automotive Engineers, Fuels and Lubricants Meeting, Tulsa, The Mayo.**
10	**California Natural Gasoline Association, 25th Annual Fall Meeting, Los Angeles, Ambassador Hotel.**
11–13	**Oil Industry Information Committee, Los Angeles, Biltmore Hotel.**
13–16	**American Petroleum Institute, 30th Annual Meeting, Los Angeles, Biltmore and Ambassador Hotels.**
26 to Dec. 1	**American Society of Mechanical Engineers, New York, Hotel Statler.**
27 to Dec. 2	**American Society of Mechanical Engineers, 19th Exposition of Power and Mechanical Engineering, New York, Grand Central Palace.**
DEC.	
3– 6	**American Institute of Chemical Engineers, Annual Meeting, Columbus, Ohio, Neal House.**
1951	
FEB. 28 Mar. 2	**Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, William Penn Hotel.**
MAR.	
5– 9	**American Society for Testing Materials, Spring Meeting and Committee Week, Cincinnati, Ohio.**
APRIL	
1– 3	**Western Petroleum Refiners Association, Annual Meeting, San Antonio.**
16–18	**American Society of Lubrication Engineers, Annual Convention and Lubrication Show, Philadelphia, Bellevue-Stratford Hotel.**
18–20	**National Petroleum Association, Cleveland, Ohio, Hotel Cleveland.**
25–27	**Natural Gasoline Association of America, Annual Meeting, Tulsa, Mayo Hotel.**
30 to May 3	**American Petroleum Institute, Division of Refining, Midyear Meeting, Tulsa.**
MAY 28 June 6	**Third World Petroleum Congress, The Hague-Scheveningen, Netherlands.**
JUNE	
18–22	**American Society for Testing Materials, Annual Meeting, Atlantic City, N. J.**

Westoil, New Company, Buys Pacific States Refinery

The newly-formed operating company, Westoil Terminals Company, has purchased the physical assets of Pacific States Oil Company in the Los Angeles harbor area. Included in the transaction were a 30,000 barrel per day refinery and more than one million barrels of bulk storage, together with about 100 acres of land. Arrangements have been made for use of the marine facilities at San Pedro.

C. Edward Miller, head of the group which organized Westoil, has resigned as chairman of Time Oil Company. Westoil has no connection as to financial operation or management with Time Oil, according to Miller.

Indiana Standard Chairman Says No Need of Rationing

Since the end of the last war, the petroleum industry has increased its capacity to produce, refine, and transport petroleum products by more than 25 percent, according to Dr. Robert E. Wilson, chairman of the board of Standard Oil Company (Indiana). It has spent more than $8 billion on additional facilities, with much of that expenditure coming from plowed-back postwar profits. For the immediate future, oil companies can supply all military requirements and meet all civilian needs on the usual scale. There is no need of rationing, even if military demand expands substantially from present levels. Competition should continue, so far as possible without governmental controls, if the strength of the industry is to be fully utilized, according to Dr. Wilson.

World Crude Increase Overrides Venezuelan Drop

The world average crude runs to stills of approximately 9.5 million barrels per day during February were 100,000 barrels per day below the January rate, due mainly to lower crude throughput in the U. S., according to a monthly report of the Bureau of Mines. Principal world crude production increases during February were as follows: U. S., 45,000 barrels per day; Saudi Arabia, 46,000; Iran, 31,000; and Indonesia, 19,000.

World crude production increased 7000 barrels per day during February to an average of about 9.5 million barrels per day, even though Venezuelan crude output was sharply curtailed, falling off 146,000 barrels per day from the record January average for that country.

Oil Refineries at Haifa Resume Israeli Operations

Oil refineries in Haifa last month resumed operations for the first time since the shutdown two years ago, when Iraq cut off pipe line supplies during the Palestine war, according to a government announcement.

Israel is buying crude oil from British and American companies to meet its

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1949:									
January 29	5,493	5,490	255,459	17,531	114,677	7,547	63,142	8,178	63,333
February 26	5,401	5,412	261,965	17,621	124,382	7,430	54,008	8,235	59,348
March 26	5,188	5,353	266,506	17,417	128,087	6,167	48,721	8,305	58,792
April 30	4,980	5,273	271,253	17,969	124,787	6,681	49,959	8,185	60,174
May 28	4,951	5,297	275,190	18,324	120,661	5,943	55,971	8,144	63,758
June 25	4,944	5,322	274,114	18,462	115,715	5,148	63,049	7,856	66,146
July 30	4,731	5,187	271,999	18,058	109,954	6,293	70,767	7,205	67,166
August 27	4,760	5,215	266,455	18,180	106,280	6,491	74,718	7,597	68,394
September 24	4,933	5,377	259,189	18,152	103,263	6,555	81,414	7,419	68,142
October 29	5,075	5,509	252,060	19,002	103,915	7,016	90,358	7,754	69,459
November 26	5,192	5,331	256,409	18,204	104,917	6,971	91,795	8,104	67,067
December 24	4,955	5,482	256,830	18,045	110,104	7,335	78,662	8,046	61,647
1950:									
January 28	4,956	5,470	248,411	18,363	124,270	7,302	66,337	8,389	57,036
February 25	5,000	5,277	245,568	17,703	133,888	6,890	56,050	7,955	48,653
March 25	4,848	5,469	244,227	17,839	135,406	6,870	40,577	8,171	42,546
April 29	5,014	5,314	244,744	18,038	128,655	6,531	36,686	7,272	39,260
May 27	5,118	5,591	240,942	18,704	122,757	7,201	40,607	7,421	39,308
June 24	5,355	5,636	240,762	19,626	115,036	6,868	50,580	7,461	41,291
July 29	5,522	5,570	240,236	19,981	109,076	7,266	61,437	7,870	42,253
August 26	5,699	6,197	236,934	20,263	105,793	7,559	65,841	8,543	41,697

annual consumption needs. Israelis hailed the resumption of refinery operations as breaking an economic blockade against their country by neighboring Arab states and by Egypt's refusal to permit Israel-bound tankers to pass through the Suez Canal.

Leach Named Executive Vice President of Texaco

J. S. Leach, vice president located in Houston, last month was elected executive vice president of The Texas Company with headquarters in New York. He continues as a director.

G. R. Bryant, general manager of the refining department, was elected vice president with headquarters in Houston, succeeding Leach.

R. F. Baker, vice president in charge of domestic producing operations, and A. C. Long, vice president in charge of foreign operations (Eastern Hemisphere), were elected directors.

J. T. Wood, Jr., assistant to the president, was elected vice president in charge of foreign operations (Western Hemisphere).

C. E. Olmsted resigned as director and vice president and is planning retirement October 1, 1950.

Pan American Posts Filled

H. C. Smith has been elected a member of the directorate of Pan American Petroleum & Transport Company, member of the executive committees of American Oil Company, Lord Baltimore Filling Stations, Inc., and Mexican Petroleum Corporation, subsidiary marketing companies of Pan American Petroleum & Transport.

R. M. Nash was also named to the boards of directors of these subsidiaries. He and Smith succeed C. H. Wagner, resigned from these companies.

Heads Research Council

Benedict Saurino, manager of the statistical research department, Sun Oil Company, Philadelphia, has been appointed by Governor Duff of Pennsylvania to head a 15-member state economic research council to help guide the state in peace or war.

Six New NPC Groups To Study Oil's Steel Needs

The newly appointed National Petroleum Council committee on petrpleum industry steel requirements has named six subcommittees to study steel materials needs for all phases of the oil and gas industry production, refining, marketing, transportation, natural gas transmission, and foreign use. The respective committees will estimate requirements for the last half of 1950 and all of 1951 by quarterly periods.

The Independent Petroleum Association of America recently revived its oil and gas field materials committee which is to provide information on distribution of steel and materials to the domestic oil producing industry in addition to requirement phases. Chairman is Bryan W. Payne. NPC committee chairman is Russell B. Brown.

Foster Wheeler Appoints Equipment Division Head

Foster Wheeler Corporation, New York, has appointed Pell W. Foster, Jr., vice president in charge of a newly created equipment division. This division will comprise the steam, industrial, marine and condenser departments, which are existing commercial engineering groups serving the power generation, industrial processing and marine industries. The new division will coordinate the activities of the present departments with the manufacturing and sales group, officials said.

Foster

Foster, a director and vice president in charge of production since 1946, will continue as active head of the production and procurement departments.

Sinclair Promotes Gardner, Other Changes Announced

C. J. Gardner, assistant superintendent at Sinclair Refining Company's East Chicago refinery, has been transferred to the Wellsville, N. Y., refinery as assistant superintendent. Gardner, who formerly was superintendent of Sinclair's refinery at Coffeyville, Kan., succeeds C. W. Hardell at Wellsville.

Hardell was process superintendent for Sinclair Rubber, Inc., at Houston prior to its shutdown in September, 1946, and he is returning to make ready for resumption of operations.

George A. Blaine who has been in charge of the technical department at East Chicago, has been appointed assistant superintendent, succeeding Gardner.

L. R. Bunger, formerly assistant to Blaine, will succeed as head as the technical department at East Chicago.

The MONTH...

Howe New Superintendent Of Refinery at Sinclair

Robert E. Howe has been named superintendent of Sinclair Refining Company's refinery at Sinclair, Wyo., effective August 1.

Howe

Howe was graduated from the Colorado School of Mines in 1933 with a degree in chemical engineering. He joined Sinclair in 1934 as an engineer in the research and development department, was transferred to Sinclair, Wyo., in 1936, and was made assistant superintendent in 1945. From 1946 to 1948 he was engineer in charge of design work on installation of fluid catalytic cracking units.

E. H. Hausner, who succeeds Howe as assistant superintendent at Sinclair joined the Sinclair organization in 1926 at East Chicago, where he was particularly active in working on the development of pressure pipe stills. In 1933 he was transferred to the Fort Worth refinery and in 1942 to Sinclair as operating foreman. In 1946 he was appointed acting assistant superintendent.

IRAA Has New Address

The address of the Independent Refiners Association of America has been changed from P. O. Box 5008, Houston 12, to 2009 Fannin Street, Houston 2. Association correspondence should be addressed to either V. E. Smith, vice president or J. W. Jackson, director of public relations. Association correspondence to IRAA's Washington office should be mailed to Norman L. Meyers, IRAA General Counsel, Shoreham Building, Washington 6, D. C.

Third Petroleum Congress

The third world petroleum congress, scheduled for May 28-June 6, 1951, will present papers on physical operations in oil processing; oil processes involving chemical conversions; production of chemicals from petroleum, their properties and applications; measurement and control, analysis and testing; construction of equipment, materials and corrosion; and economics, statistics, and documentation.

These papers and others will be pub-

The MONTH...

lished in the proceedings of the congress. Closing date for acceptance of manuscripts was September 1. The congress will be held at the Hague-Scheveningen in the Netherlands.

Becomes Chief Engineer With Asphalt Institute

Walter F. Winters, former special projects engineer at the Denver office, has been promoted to chief engineer of The Asphalt Institute with headquarters, 801 Second Avenue, New York 17. Bernard Gray, now serving as president and chief engineer, is succeeded in the latter post by Winters.

Winters

Winters will direct the staff in promoting the use of asphalt for roads, streets and airfields, and developing requisite research for these and additional uses.

Winters' training includes the engineering course at Washington State College with supplementary courses at the University of Virginia and Northwestern University.

Asphalt Paving Tonnage Up, New Members Join Institute

Petroleum asphalt and road oil used for paving in the U. S. during 1949 reached approximately 7.4 million tons or nearly three percent higher than the record 1948 figures, according to a recent Bureau of Mines report. This paving tonnage represents 73.7 percent of the asphalt and road oil total figure for 1949 of approximately 10 million tons.

Four new members to join The Asphalt Institute are Empire Petroleum Company of Denver, Colo., Pan-Am Southern Corporation of New Orleans, Southland Oils, Inc. of Rogerslacy, Miss., and A. Johnson Company of Sweden. Membership in the institute totals 40.

Recently appointed district engineering representative for the institute was William H. Rhodes who will cover Louisiana and Mississippi, assisting William H. Mills, district engineer in Atlanta, Ga. Mills territory includes Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina and Tennessee.

Sinclair Superintendent Heads Hartford Operations

Formerly foreman of Sinclair Refining Corporation's Houston refinery, R. I. (Jake) Jacobi has been appointed assistant superintendent in charge of operations of its newly acquired refinery at Hartford, Ill.

Jacobi first joined Sinclair in 1930 in the technical department of the Marcus Hook, Pa., refinery. After graduation in 1931 from Colgate University, Jacobi joined the technical division of the Houston refinery. He subsequently received an M.S. degree in petroleum refinery engineering from the University of Oklahoma and returned to the Houston plant where he also served as head of the technical department.

McNealy Named Assistant By Texaco at Eagle Point

E. W. McNealy has been appointed assistant superintendent of The Texas Company's new Eagle Point Works at Westville, N. J., W. G. Copeland, superintendent, has announced.

McNealy, a native of Texas, began his career with The Texas Company as a summer employe at the Port Arthur, Texas, refinery. After his graduation from Rice Institute in 1932, he went to Port Arthur as a chemist and served in this capacity and as assistant foreman except for a short period at the Beacon, N. Y., Laboratories. In 1939, he was transferred to San Antonio as a process engineer, in which capacity he also worked at the company's plant in Los Angeles and in the managerial office of the refining department in New York. Since August, 1949, McNealy has served as assistant superintendent of the company's Casper, Wyo., works.

Cities Service Oil Names Bartlesville Refinery Head

William T. Cravens, formerly assistant general superintendent, has been appointed general superintendent of Cities Service Oil Company (Delaware's) Bartlesville, Okla., refinery. Cravens served a year as government project engineer after graduating in 1936 from the University of Arkansas with a degree in chemical engineering. His early training was with Arkansas Fuel Oil Company, Shreveport, La., and the Bossier City plant with which he served as refinery engineer. From 1942 to 1947 Cravens was chief process engineer of Cities Service Refining Company's Lake Charles, La., refinery. Before his transfer to Cities Service Oil at Bartlesville, he was chief process engineer of the manufacturing division of Petroleum Advisers, Inc., New York, a service organization of Cities Service Company.

Assistant Chief Engineer Named by Cities Service

John D. Snakenberg, plant manager of the East Chicago, Ind., refinery of Cities Service Oil Company (Delaware) has been appointed assistant chief engineer of the manufacturing department, New York. He will be succeeded by L. E. (Spike) Taylor, formerly superintendent of operations at the Lake Charles, La., refinery of Cit-Con Oil Corporation.

Texaco School Studies Diesel Engine Research

Diesel research facilities at The Texas Company's Beacon, N. Y., laboratories were the focal point of a diesel engine manufacturer's association school held August 28-September 1 in New York.

University and college professors and instructors, specializing in diesel engineering, as well as research engineers from Texaco, attended the five-day session. The program covered diesel engines, their fuels and lubricants. The Beacon labs are the main research center of The Texas Company.

Six Fill Executive Posts In New Texaco Promotions

Worden

Holmes

Logan

Mangelsdorf

A series of promotions in the refining department of The Texas Company, effective August 15, were announced as follows:

McCray

J. S. Worden, formerly manager of operations, New York, has been appointed general manager, New York, replacing G. R. Bryant, recently elected vice president at Houston. W. B. Logan, assistant manager of operations, has been made manager of operations; F. H. Holmes, general superintendent of the Port Arthur, Texas, works, replaces Logan in New York as assistant manager of operations; T. A. Mangelsdorf, now superintendent of the Lockport, Ill., works, becomes general superintendent of Port Arthur works; H. S. McCray, superintendent of Lawrenceville, Ill., works, has been made superintendent of Lockport works; and H. A. Lord, formerly assistant general superintendent of the Terminal division, New York, will become superintendent of Lawrenceville works.

Gustav Egloff Honored

Dr. Gustav Egloff, director of research, Universal Oil Products Company, Chicago, has been elected a Fellow of the Royal Society of Arts of Great Britain.

Walter Miller Retires

Walter R. C. Miller, coordinator of the world-wide mechanical shop modernization program of Standard Oil Company (New Jersey) has retired after more than 30 years service.

Miller started his company service as a draftsman with the Midwest Refining Company in Wyoming in 1919. He was

THIS MAN IS DELIVERING A *Petroleum Refinery*

He's a McKee Company Engineer, and along with the plans he carries, he delivers the specialized services and long, world-wide experience of the McKee organization. Symbolized behind him are the technical experts and skilled personnel necessary for the construction of a single processing unit.

During the past year the McKee organization had in process of completion, simultaneously, 35 petroleum refinery and iron and steel plant projects in the United States and 10 foreign countries.

Arthur G. McKee & Company has the men, the experience and the resources to undertake petroleum refinery and iron and steel plant projects of any size in any location.

ARTHUR G. McKEE & COMPANY

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

ENGINEERS AND CONTRACTORS • ESTABLISHED 1905
2300 CHESTER AVENUE, CLEVELAND
30 Rockefeller Plaza, New York, N. Y.

The MONTH...

transferred to the Lago Oil and Transport Company in 1928 and was sent to Aruba, N.W.I., with the first refinery construction group as head of the pipefitters department and was there when the refinery first started operation in 1929. He was appointed mechanical superintendent of the Aruba Refinery, and in 1947 was transferred to the Standard Oil Development Company.

Conoco Names Directors For Houston Offices

Ritter

Bailey

J. R. Bailey, former assistant director of natural gasoline and gas operations in Continental Oil Company's production department, has been promoted to director, with C. L. Ritter, former superintendent, natural gasoline and gas operations, succeeding Bailey as assistant director. Bailey replaces F. B. Haverfield, resigned.

Bailey, who has served the Conoco refinery at Baltimore, Md., and done engineering work in Louisiana, was division engineer in natural gasoline and gas operations, superintendent of development, and assistant director at Ponca City, Okla., before moving to Houston early this summer. Bailey first joined Continental in 1927 in the Glenrock, Wyo., refinery.

Ritter, who joined in the production department at Lance Creek, Wyo., has also been with the company at Tepetate, La., and Ponca City, Okla., where he was superintendent of operations. He also moved to Houston early this summer.

Reserve Calls Engineers From General American Unit

The 433rd engineer petroleum distribution company, which has been sponsored by General Petroleum Corporation under the affiliated unit plan of the organized reserve corps, has been called to active duty by the U. S. 6th Army Reserve Group.

General Petroleum men in the unit include Captain John Burnett, commander and member of the General American refining department, H. W. Barham, M. J. Bourdon, C. H. Fannin, B. G. Kintner, S. S. Larson, P. L. Miller, Richard Rothschild, R. L. Shaeffer, C. E. White, and P. N. White.

Corrosion Engineers Hold 1951 Meeting in New York

Plans for the 1951 conference and exhibition of the National Association of Corrosion Engineers are well underway, according to General Chairman L. B. Donovan, Consolidated Edison Company of New York, Inc. The meeting will be held in New York, March 13-16. Professor Norman Hackerman of the University of Texas, chairman of the technical program committee for the conference has projected arrangements for 39 papers.

Symposia will be held on corrosion principles; cathodic protection; protective coatings; industrial use of corrosion inhibitors; food, water, pipe line, chemical, transportation, oil and gas, and electrical and communications industries. Round table discussions will be on general corrosion problems and pipe line and underground corrosion.

Heads Bayonne Lube

Robert M. Hunt has been appointed supervisor of lubricating oil and wax manufacturing operations at the Bayonne, N. J., refinery of Tide Water Associated Oil Company.

Hunt started with Tide Water in 1946 as a process engineer in the process department and in 1947 was promoted to technical assistant to the process superintendent, the position he held until his recent advancement.

Belchetz Now Consultant

Dr. Arnold Belchetz, formerly chief technologist for Shell Petroleum Corporation and later head of the new processes department, The M. W. Kellogg Company, is now practicing as a consultant to the petroleum and chemical industries.

Dr. Belchetz was at one time director of research and development for Stauffer Chemical Company. His consulting offices are located at 125 Woodbine Avenue, Larchmont, N. Y.

U. S. Oil Product Tax Levies Jump from Year Ago

Federal tax collections on oil products soared during July from the same month a year ago, according to a monthly report of the Internal Revenue Bureau. Gasoline tax take rose from approximately $37.6 million to $46.6 million. Lubricating oil levy rose to nearly $6.1 million in July from $4.7 million collected the same month a year ago, while tax collected on oil transported by pipe line increased to $1.7 million from $1.2 million.

General Petroleum Enlarges Manufacturing Department

The manufacturing department, which at present includes the refining, gas, and laboratory operations of General Petroleum Corporation, now includes, in addition, the engineering and construction operations. Gale L. Adams is vice president and director of manufacturing for the company.

Phillips Founder Dies

Frank Phillips, 76, founder of Phillips Petroleum Company and honorary chairman of its board died August 23 in Atlantic City, N. J., following an operation.

Phillips, together with his brother, formed the company in 1917. He retired after 21 years as president in 1937.

Plant Superintendent Dies

Oscar M. Brown, 64, plant superintendent for Mid-Continent Petroleum Corporation refinery in West Tulsa, Okla., died August 16 from a heart attack.

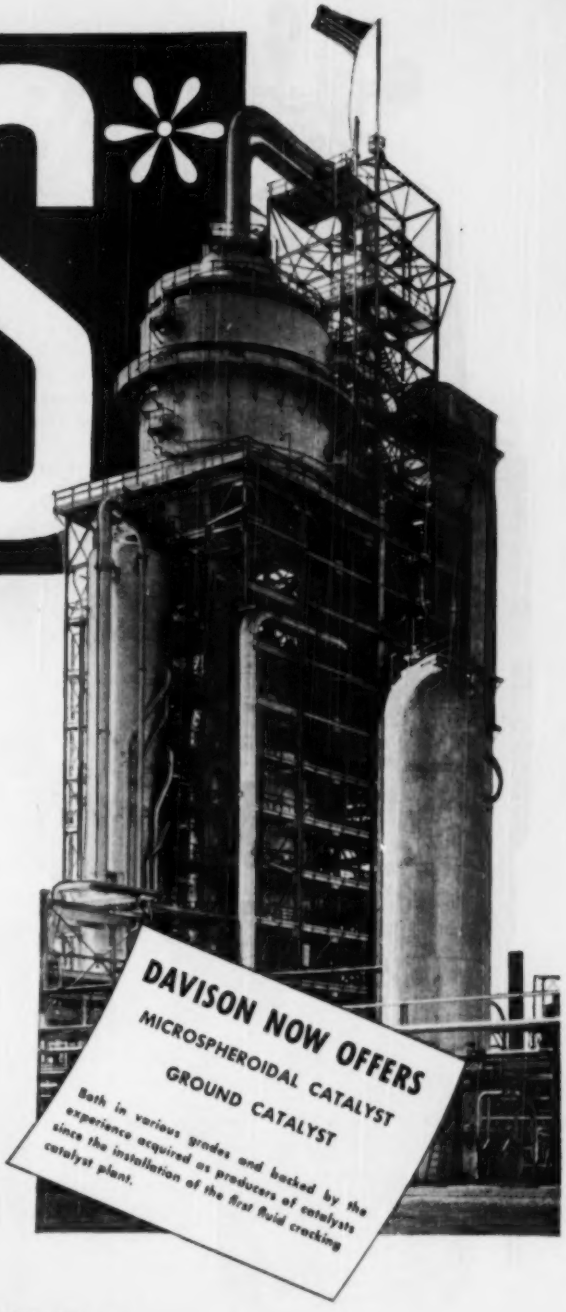
Further Plant Facilities Contemplated

The advisory committee for the North Snyder, West Texas, gasoline plant to be managed by Sunray Oil Corporation for 35 operators, has let contracts for pipe line construction and has announced that the $6.8 million unit will be equipped to produce iso-butane. The committee, shown in the picture, includes, left to right, seated: R. W. Johnston, Cities Service Oil Company, Bartlesville; A. V. Murray, Sunray; H. W. Manley, chairman, Sunray; E. A. Brown, Lone Star Producing Company, Dallas; Helen Wells, committee secretary, Sunray; J. C. Birdsall, L. M. Lockhart, Corpus Christi. Standing: D. S. Wallace, Fullerton Oil Company; J. R. McMillan, Fullerton Oil Company, Pasadena, Calif.; L. G. Rodgers, Sunray; J. M. Kindle, Lone Star; M. R. Lents, Scurry Natural Gasoline Company, Houston, and J. A. Craig, Skelly Oil Company, Tulsa.

The Vaughn and Taylor Construction Company of Wichita Falls, Texas, will lay approximately 130 miles of low-pressure gas gathering lines from 30 inches down to 4 inches in size, preparatory to construction of casinghead gas plant proper.

The committee is negotiating with The Fluor Corporation for construction of plant processing facilities. The unit is designed to process approximately 50 million cubic feet of gas per day and with 70 percent propane extraction will produce approximately 420,000 gallons per day of liquid products.

M-S*


DAVISON NOW OFFERS
MICROSPHEROIDAL CATALYST
GROUND CATALYST
Both in various grades and backed by the experience acquired as producers of catalysts since the installation of the first fluid cracking catalyst plant.

DAVISON MICROSPHEROIDAL CATALYST

In order to serve the petroleum industry's needs for synthetic fluid type cracking catalyst in microspheroidal form, Davison is installing spray drying facilities in its Cincinnati, Ohio catalyst plant. The installation is scheduled for completion by October, 1950.

The new equipment includes the largest spray drying chamber yet installed for the purpose of making petroleum cracking catalyst. It will be capable of producing several grades of catalyst in microspheroidal form, each having unusually favorable particle size distribution.

The chamber will be built entirely of stainless steel; and with other special processing equipment, the catalyst produced will equal the high standards of quality inherent in all Davison products.

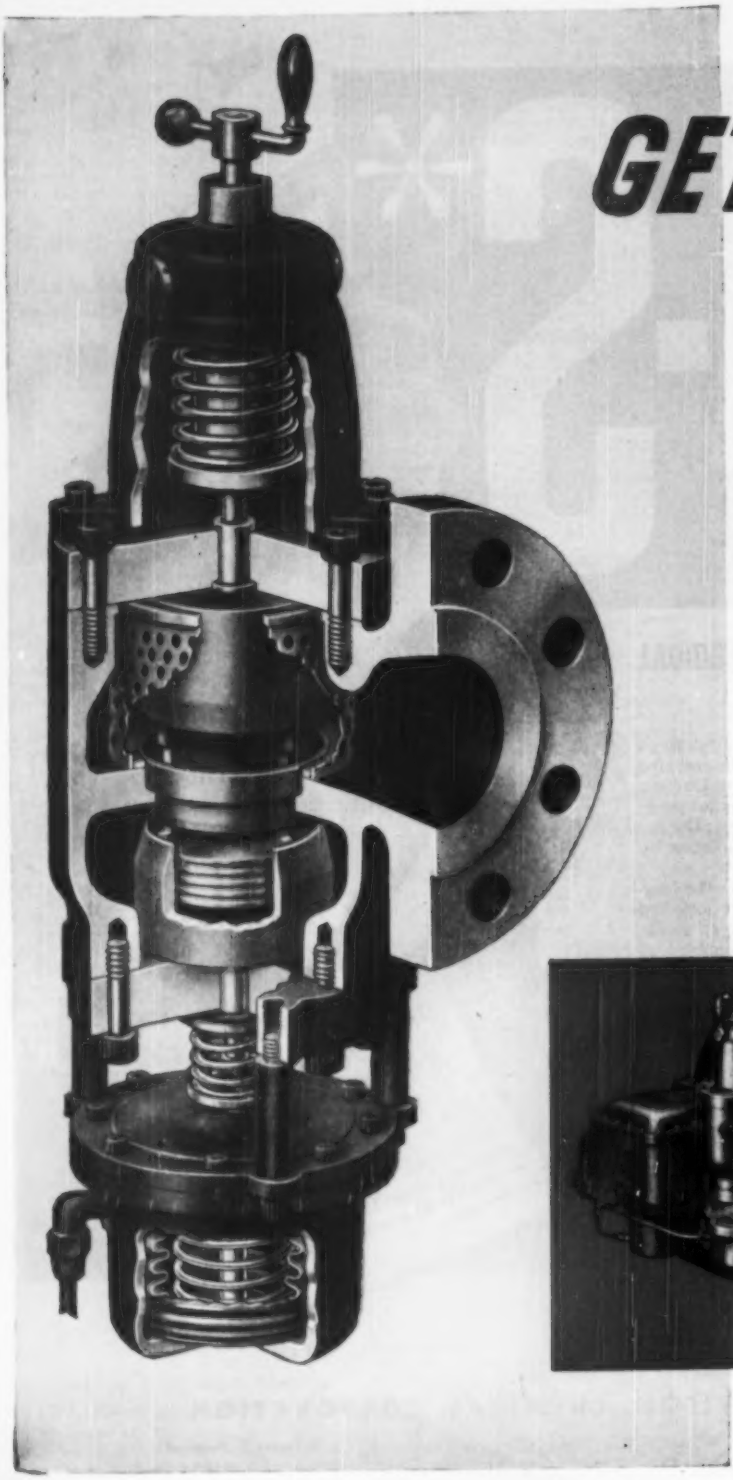
Now, your requirements for fluid synthetic cracking catalyst can be supplied by Davison in either microspheroidal or ground form and you can depend on Davison for reliable and cooperative service.

* T.M. T.D.C.C.

PROGRESS THROUGH CHEMISTRY

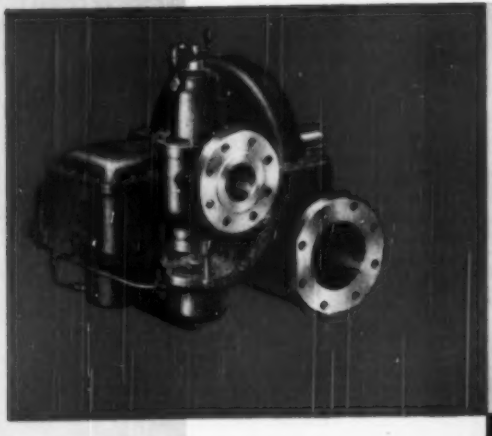
THE DAVISON CHEMICAL CORPORATION

Baltimore 3, Maryland



GET THE

TYPE
DP



BEST IN VALVING

WITH STANDARD TURBINE DRIVES

On General Electric's standard Type DP mechanical-drive turbine, the trip-throttle valve and the governing valve are combined into one casing. This exclusive G-E feature provides a compact and neat design which simplifies piping by usually eliminating the need for a separate valve in the steam line. You get easier operation, too, because pressures across the valves are equalized. The throttle valve mechanism is ball-bearing mounted, and only hard packings are used.

POSITIVE OVERSPEED PROTECTION

A bolt-type emergency governor, mounted in the turbine shaft, actuates a trip mechanism when speed rises 15% above normal. This action trips the throttle valve closed, positively shuts off steam flow to the turbine. A convenient hand lever is also provided for tripping the valve.

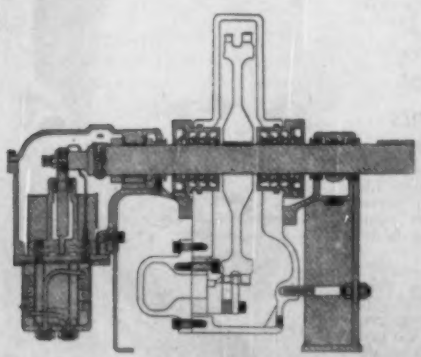
BETTER GOVERNING AND REGULATION

Working with the DP's powerful hydraulic governor, the governing valve gives you greater performance accuracy. The balanced reaction design reduces valve unbalance to a minimum. Relief holes equalize pressure between the valve and the guide piston of the seat. Hard packing decreases the force required to move the valve, results in smoother operation.

LONG LIFE AND DEPENDABILITY

The stainless steel stem and nitrided stainless steel valve and seat are designed to last for years. Maintenance is cut through the use of corrosion-resistant labyrinth stem sealing bushings. No soft packings are used. An easily removable monel steam strainer in the throttle valve chest halts foreign material before it can reach valve or steam parts.

Look into *all* the features of the standard DP turbine. You'll find many extras, such as the valving, which can give you the performance and savings you want from a mechanical-drive turbine. Contact your nearest G-E sales office, or write for bulletin GEA-4955. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*



HOW STANDARDIZATION WORKS FOR YOU

In the diagram at the left, all shaded parts are interchangeable on all sizes of DP turbines. Thus, it is easy to stock spares, and maintenance costs are reduced. All models have standard shaft height and coupling fits for easy installation or re-location in your plant. Standardization cuts manufacturing expense and the savings are passed on to you in the form of extra features, usually found only on "special" turbines.

GENERAL ELECTRIC

REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others active in the industry.

C. H. WATKINS

R. M. DEANESLY

WARREN R. JENSEN

Deanesly-Watkins Co-Author Article

R. M. DEANESLY, author of "Autothermic Cracking for Ethylene Production," page 217, was born in England and received his B.A. and M.A. degrees from Oxford University. He took postgraduate chemical engineering studies at the University College, London, and in 1927 joined Shell Oil Company in California. From 1928 to 1942 he was with the research staff of Shell Development Company, Emeryville, Calif., and from 1943 to 1945 was with Kellex Corporation. In 1945 he joined Universal Oil Products Company and is now engaged as chemical engineer in the research department. Deanesly is a member of the Institution of Chemical Engineers of Great Britain.

The Deanesly family, including Mrs. Deanesly and two daughters, has a cabin in the Sierras where they sometimes vacation from suburban activities in Chicago. Fly fishing and gardening are favored as hobbies.

Deanesly's colleague in research on the current article, Dr. C. H. Watkins, however, has limited outside interests, believing that a wife, two sons and two daughters can be enough hobbies for any man.

Dr. Watkins, a native of Kentucky, was graduated in 1935 from the University of Louisville with a B.S. degree in chemical engineering and in 1936 with an M.S. Three years later, after receiving his Ph.D. from Purdue University, Dr. Watkins joined Standard Oil Development Company, Elizabeth, N. J., where he worked until 1946 at which time he joined UOP.

Dr. Watkins is a member of Sigma Xi and the American Institute of Chemical Engineers.

Watches Start-Up of Graphic Panel Plants

WARREN R. JENSEN, author of "Graphic Panels in Operation," page 139, was present during the "start-up" period of four of the eight refineries using graphic panels which are listed in his article.

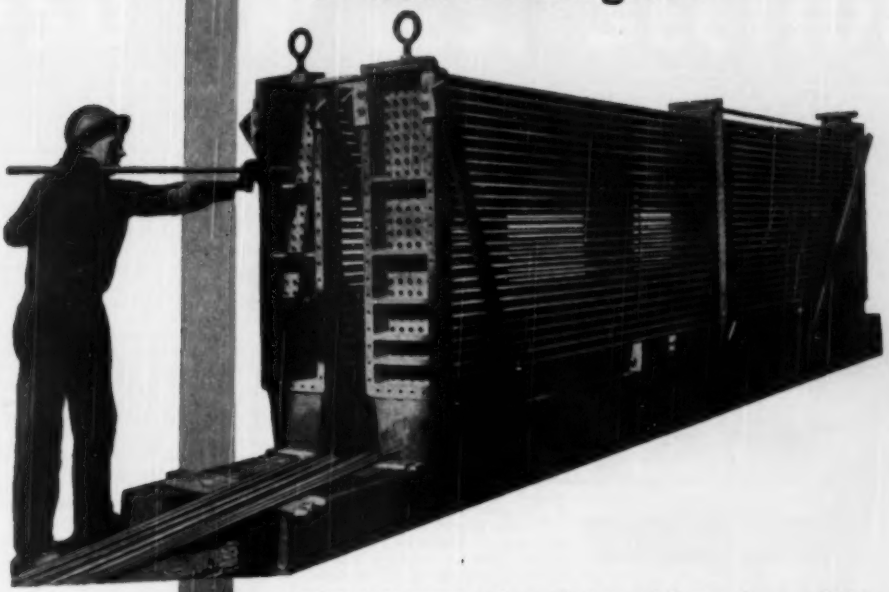
Jensen is a sales and service engineer with Moore Products Company. Prior to entering this particular field, he worked in the company's training program which included service in the production, assembly, and calibration departments.

A member of ASME, Pi Tau Sigma, Tau Beta Pi, Phi Kappa Phi, and the Blue Key, Jensen received his B.S. degree in mechanical engineering from Drexel Institute. Three years of Army service included duty in the European and Pacific theaters.

Jensen and his wife, Carolyn, both fond of the outdoors, often indulge in camping, boating, and fishing, with gardening and photography rounding out their duo interest.

JOHN M. CROTHERS

What technical service can Anaconda give you on Heat Exchangers?



ANACONDA Arsenical Admiralty Tubes being installed in tube bundle at Lemont, Illinois plant of Globe Oil & Refining Co. Fortified against dezincification by the arsenic content, tubes of this ANACONDA Alloy are being used with good results in many types of petroleum refining and other process equipment.

EVERY LARGE USER and manufacturer of heat exchangers builds up wide experience with tube and tube sheet materials. But The American Brass Company serves many such users and manufacturers, shares with each their toughest problems, makes this wider experience available to all.

Special laboratory facilities are maintained for this work. Detailed records of problems, conditions, findings are accumulated. These data, plus the results of continuous laboratory and field tests, are used to solve new problems.

These facilities can help produce the answers to your questions—suggest materials that will give your heat exchangers more dependability, longer life, more value under specific conditions.

We hope you will work with us—let us work with you. Write for Publication B-2, "ANACONDA Tubes and Plates for Condensers and Heat Exchangers." Please address The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

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For efficient heat transfer ANACONDA® HEAT EXCHANGER TUBES

Shell Metallurgist Contributes Article

G. A. NELSON, author of the article "Metals for High-Pressure Hydrogenation Plants," beginning page 104, attended Armour Institute, Lewis Institute, and the Massachusetts Institute of Technology. Presently, he is a staff metallurgist for Shell Development Company in the engineering department, San Francisco, having formerly served as metallurgist at Shell Chemical Corporation's ammonia plant, Pittsburgh, Calif.

Nelson is a member of Sub-Group XXII of Committee A-1 of the American Society of Testing Materials and also is a member of ASM, Golden Gate Chapter, of which he is a past chairman.

G. A. NELSON

Electrical Engineer Also Navy Commander

JOHN M. CROTHER's responsibilities as an electrical engineer with Catalytic Construction Company include both design and construction phases. His article "Emergency Electrical Equipment Justified as Initial Plant Investment," appears in this issue starting on page 133. With the firm since 1946, Crothers is a registered professional electrical engineer in the state of Pennsylvania, and is a lieutenant commander, USNR. He received his technical education at Drexel Institute and Johns Hopkins University.

Crothers' engineering career began with Philadelphia Electric Company in 1924. In 1929 he became an electrical designer for Pennsylvania Power and Light Company. From 1933 to 1946 he was a designer with Sun Oil Company.

Major sports are hunting and fishing.

Describes Platforming

JESSE F. WRIGHT

JESSE F. WRIGHT, author of the article on "Platforming," page 163, received his bachelor of chemical engineering degree from the University of Minnesota in 1938. Following his graduation he became associated with Universal Oil Products Company as a member of the pilot plant division.

During World War II he served with the rank of Major in the United States Army chemical warfare division in the Pacific Theater of Operations for 40 months.

Upon his return to Universal from service he rejoined the pilot plant division for a year and in 1946 was appointed to his present position as a member of the staff of the commercial development department.

Phillips Employe Gets a Fat Check

WESLEY MASON, an operator supervisor at Phillips Petroleum Company's Rice gasoline plant, Phillips, Texas, recently received a $500 check for an operating suggestion which he made to the company. This check, the highest amount ever paid in the company's suggestion award plan, was given at a dinner meeting of 150 department employees and their families.

F. E. Rice, vice president of the company's natural gasoline and gas department who made the presentation, commended Mason for his interest in the company and pointed out that the idea was conceived by Mason's observation of operations beyond the scope of his regular assignment.

The suggestion which drew the record award was that bauxite, which is used in the isomerization unit, need not be discarded after a single use but that it could be reclaimed and used again. This reclamation method has been put into full-scale operation and actual data have proved that Mason's idea and procedure were correct and have resulted in a substantial operating economy.

The Mason reclamation method consists of neutralizing the acidic contents which are deposited in the bauxite bed during the plant operation and then drying the neutralized material in a direct-fired heater.

The company's suggestion committee receives some 1200 suggestions yearly from employes and about 30 percent are accepted as worthwhile, Rice declared. Employes are encouraged to submit ideas on improvements in manufacturing and producing methods, reduction in cost, prevention of waste, and the improvement in products.

Wesley Mason (left), an operator supervisor at Rice Gasoline Plant, is presented a $500 check by F. E. Rice, vice president of the natural gasoline and gas department of Phillips Petroleum Company.

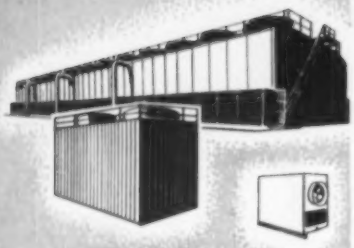
PETROLEUM
REFINER

1950 PROCESS SECTION

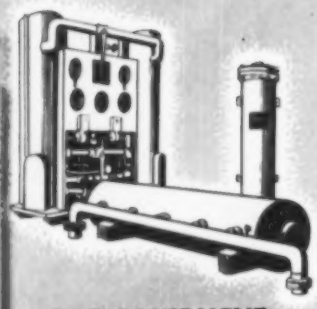
Design, Engineering,
Construction
and Protecting Services

Manufacturers of
SPECIALIZED EQUIPMENT
- Cooling Towers
- Air Cooled Heat Exchangers
- Air and Gas Treating Equipment

Specialized Process Equipment Manufactured by the Equipment Division of J. F. Pritchard & Co.



COOLING TOWERS



GAS EQUIPMENT

AIR COOLED HEAT EXCHANGERS

COOLING TOWERS

Whenever heat is to be dissipated to the atmosphere, you can rely on a Pritchard Cooling Tower to do the job more efficiently and economically at *water savings up to 99% over former wasteful methods.* Pritchard Industrial Cooling Towers are available in any size for any capacity and are always manufactured of highest quality materials.

Adequately sized and thoroughly engineered for long life and trouble-free performance, Pritchard Towers are guaranteed to meet your peak as well as your normal load requirements. Rugged structural strength in Pritchard towers results from the employment of conservative standards for both wind and load stresses. All Redwood frame members are liberally sized with ample diagonal bracing and steel ring connectors.

Both mechanical draft and natural draft (atmospheric) cooling towers are available from Pritchard to meet your requirements. Experienced field superintendents and complete construction crews are available to handle field installation efficiently.

GAS EQUIPMENT

Included in the Equipment Division's line of air and gas treating equipment are the following:

HYDRYER* . . . low cost packaged dehydration unit using solid adsorbent agents for removal or control of water vapor from streams of compressed air and other gases. Available in standard sizes or built to your specifications.

OILSORBER* . . . prevents fouling of adsorbent beds. Also used for removal of entrained oils, line condensates and dirt from compressed air and gas lines.

PURIDRYER* . . . highly efficient air treater for the purification and positive control of temperature and humidity in pressured air systems.

SULPHURSORBER* . . . packaged hydrogen sulphide removal unit—amine type—for treating gas flows up to 3 million SCF/day. Economically converts sour gas into usable fuel.

HYDROSORBER* . . . packaged gas dehydration unit of liquid glycol absorption type offering the most economical dehydration of gas flows up to 3 million cubic feet per day.

MISTRAP* . . . horizontal gas scrubbers designed to remove entrained liquids, dirt, scale, etc., from natural gas. Especially suited to main transmission pipe lines.

HEAT EXCHANGERS

Air cooled heat exchanger equipment manufactured by the Equipment Division of J. F. Pritchard & Co. includes:

QUINTAIR* . . . designed for the cooling or condensing of steam or process vapors, natural gas, jacket water, lubricating oil, quenching baths and other liquids, gases and vapors. Available in several types and sizes. A single unit may be used for various simultaneous cooling duties. Completely prefabricated and shipped ready for fast, easy installation.

QUINTEX* . . . atmospheric heat exchanger sections (either high or low pressure designs) are available in both horizontal and vertical types for every condensing or cooling application.

QUINTUBE* . . . specialized process shell and tube heat exchanger. Made to order for special applications.

*Registered Trade Name

Producers of QUALITY Specialized Process EQUIPMENT

For Additional Information on Any Item of Specialized Process Equipment Described Above, Write for Free Bulletins.

EQUIPMENT DIVISION

J.F. Pritchard & Co.

Dept. No. 94 908 Grand Ave., Kansas City 6, Mo.

PROCESS SECTION

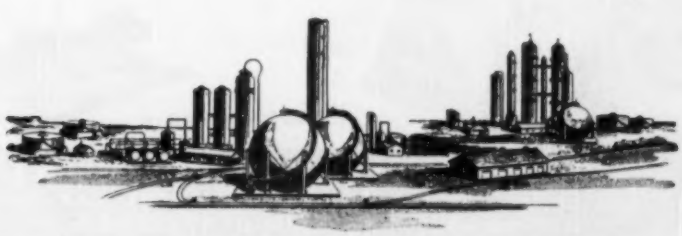
PETROLEUM REFINER • 1950

THE tremendous growth of the oil industry—indeed the development of the whole American way of life—is intimately, inseparably, related to the gradual building over the years of a superb technology for the manufacture of petroleum and natural gasoline products—fuels, lubricants, road surfacing materials, and petrochemicals. Our systems of transportation by aeroplane and automobile are entirely dependent on petroleum products. Rail and water transport are to a large degree powered with liquid petroleum fuels. The machinery of our industrial civilization, lubricated by petroleum oils and greases, would without them grind to a squeaky halt.

The evolution of this technology has been gradual though fairly constant. While progress in any given year has not always been notable, there is probably no single ten-year period that has not witnessed an almost amazing record of accomplishment. For instance, catalytic cracking was at the fixed-bed stage ten years ago, and not used commercially in the mid 1930's. Only a few alkylation units had been built in 1940. Large combination units for crude distillation, thermal cracking, and naphtha reforming were extensively used by 1940, but comparatively little known in 1930.

Improvements in mechanical equipment design, in materials of construction, in control apparatus, and operating techniques, have all played a part. Over-all, however, the gradual improvement of basic hydrocarbon separation methods, the discovery and development of processes for converting low-value hydrocarbons to more salable materials, and for treating to improve product quality have been all important. As markets for basic petroleum products have increased and markets for new products appeared, processmen have devised ways to maximize their production of the more valuable products. Innumerable process schemes have been set up. The more practical ones, those that worked process-wise and mechanically, have been used either briefly or through the years on the basis of one all-important factor — whether or not they made a profit for the operator greater than could be made by some other route.

This September issue of PETROLEUM REFINER has been designated the 1950 Process Issue. Following an established practice, it is largely devoted to a treatment of oil industry processing schemes. In one respect, however, it differs sharply from earlier process issues. Most of the processes that have been used by the oil industry were described in the September, 1949, issue of PETROLEUM REFINER, and that issue might well be termed a process encyclopedia. There is little reason to repeat this treatment so soon. Instead this present issue includes reports on processes of high current interest—processes that have either been introduced or markedly improved within the past year or so.



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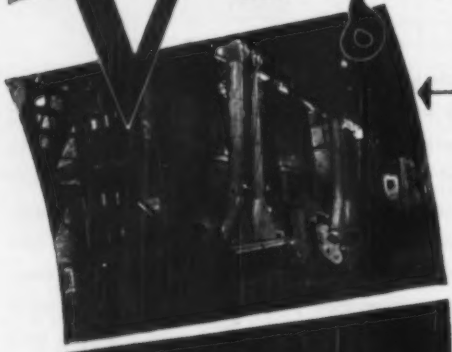
Vogt Products

For Today's Tough Service Demands

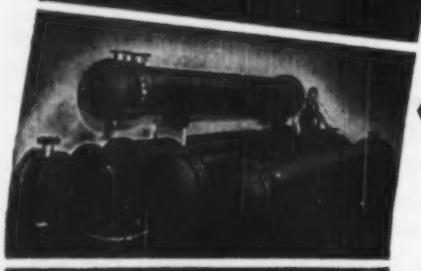


EFFICIENT AND DEPENDABLE STEAM GENERATION

Vogt steam generating units are designed to give maximum rating in a minimum of space with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels, as desired, meet every power, heating or process requirement.

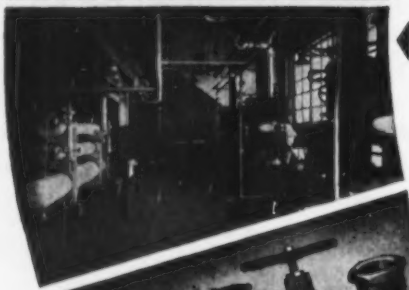
PROCESS EQUIPMENT FOR EVERY SERVICE

Stills, towers, oil chilling machines, filter presses, heat exchangers, etc. are constructed to all Codes. They meet all demands for operating security and trouble-free performance and help to lower costs in important process industries around the world.



SPECIAL MATERIALS FIGHT CORROSION AND PRODUCT CONTAMINATION

Our modern shops produce a wide variety of equipment made from special metals and alloys to combat corrosion, and product contamination or discoloration. Fabrication procedures employed insure that corrosion resistant properties of welds will match that of the materials from which units are constructed.



MORE TONNAGE AT LESS COST

Over 60 years of manufacturing experience, engineering and research stand behind Vogt refrigerating and ice making machinery. Absorption Systems, Compression Systems, and the Automatic Tube-Ice Machine in a wide range of capacities serve in leading petroleum refineries, chemical plants, ice and cold storage plants, dairies, packing plants, etc., at home and abroad.

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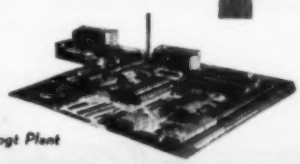
Vogt valves, fittings and flanges, for top performance in oil, water, air, gas, and ammonia services, at high or low pressures and temperatures, are available drop forged entirely from carbon steel or stainless steel. Valves can be furnished in a combination of materials by using stainless steel for parts affected by service temperature or corrosion, and less expensive alloys or carbon steel for other parts.



Air View of Vogt Plant

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

BRANCH OFFICES NEW YORK PHILADELPHIA CLEVELAND CHICAGO ST LOUIS DALLAS

PLATFORMING—New Continuous Catalytic Reforming Process Operates on All Types Virgin Stocks

JESSE F. WRIGHT
Commercial Development Department Staff
Universal Oil Products Company, Chicago

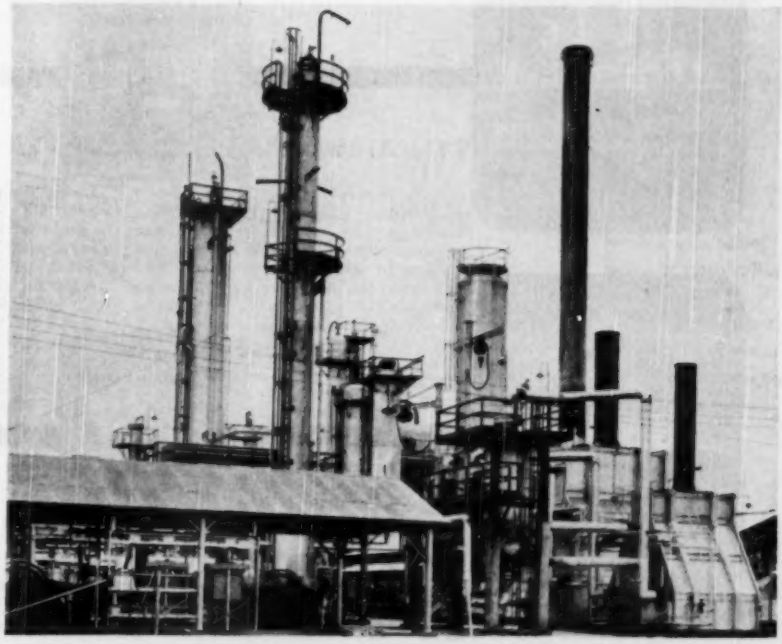
THE UOP Platforming process is a recent development in petroleum processing for improving the octane rating of straight-run, natural and cracked gasolines.

PLATFORMING is a continuous non-regenerative catalytic reforming process by which gasolines are reformed at a high liquid volumetric recovery in the presence of a platinum catalyst in a hydrogen atmosphere, to obtain high-octane number products. This result is accomplished by utilizing the combination of five principal reactions which lead to octane improvement as follows:

1) Dehydrogenation of naphthenes to aromatics.
2) Hydrocracking of high-molecular-weight paraffins to lower-molecular-weight paraffins.
3) Isomerization of paraffins and of naphthenes.
4) Cyclization of paraffins.
5) Desulfurization of sulfur compounds forming hydrogen sulfide.

Platforming will successfully handle all types of virgin stocks boiling in the gasoline range. Platforming produces a high-quality, non-olefinic gasoline from heavy straight-run or a blend of heavy straight-run and heavy thermal cracked gasolines or naphthas. Advantages cited for the process are as follows:

1) The laboratory knock ratings are upgraded by as much as 50 octane numbers.
2) The lead susceptibility of the

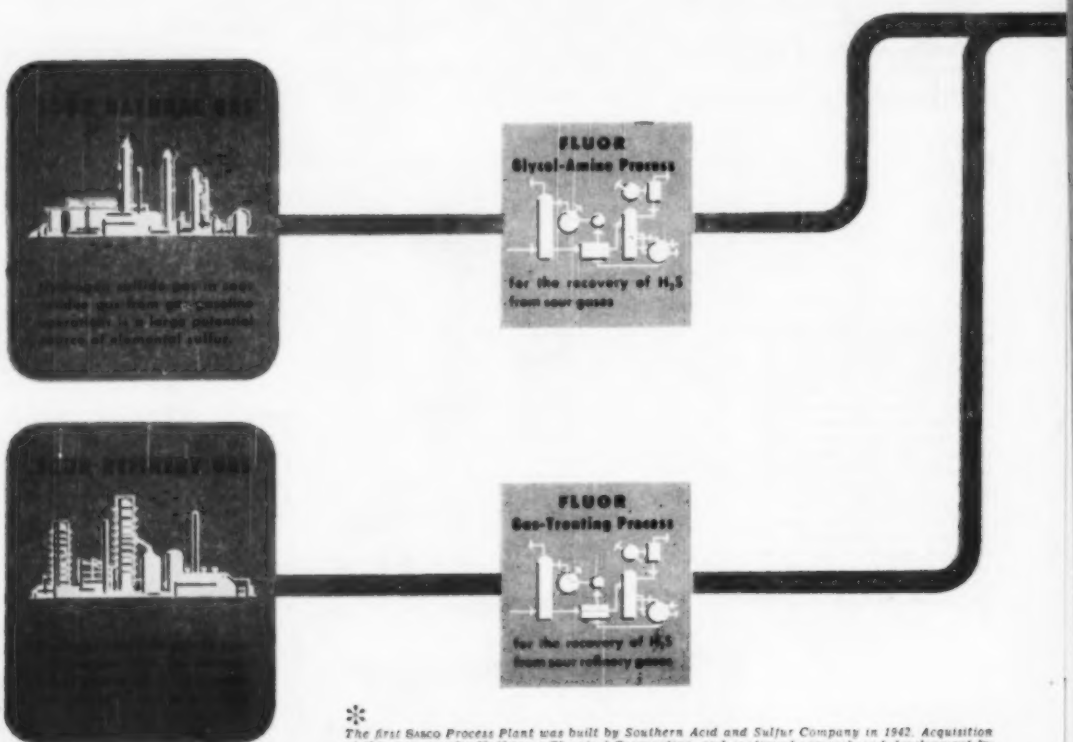


Platforming unit at Old Dutch Refinery, Muskegon, Mich. Recycle gas compressors, motor driven, are under the shelter roof. The two towers at the left center are respectiveiy the prefractionator and the gasoline stabilizer. Three reactors are at the right center on a concrete support structure. The three heaters just behind and to the left of the reactors serve the platforming unit. The pump house is on the extreme left. The balance of the towers in the right center background, the tall stack, and the heater on the extreme right are used in crude distillation and thermal cracking service, not part of the platforming unit.

FLUOR has the answer to

SULFUR ...FROM SOU

Now, for the first time, the Mathieson *Sasco Process for the commercial recovery of elemental sulfur from waste hydrogen sulfide gas is available to operators of petroleum refineries and natural gasoline plants. An agreement between The Fluor Corporation, Ltd., and Mathieson Chemical Corporation designates Fluor as the sole licensing agent for the engineering and construction of sulfur recovery plants incorporating Mathieson's Sasco Process. All details, including first studies, are available through Fluor.

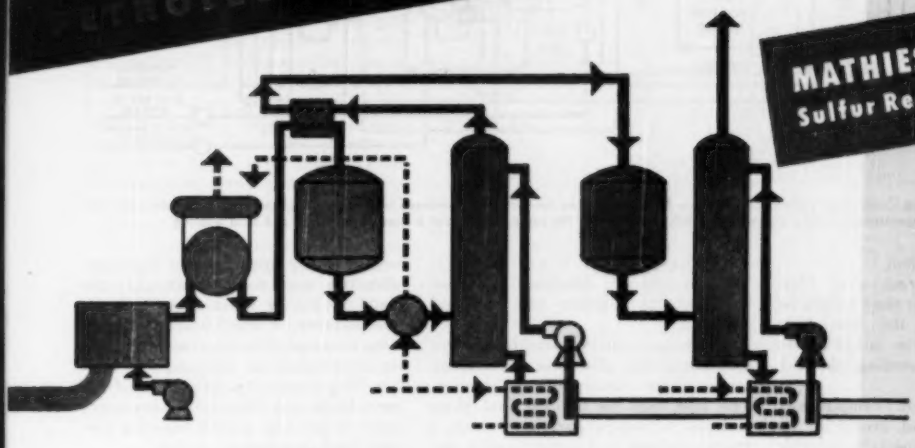


*The first Sasco Process Plant was built by Southern Acid and Sulfur Company in 1942. Acquisition of this company by Mathieson Chemical Corporation, and continued research and development by Mathieson personnel mark this process for recovery of sulfur from waste hydrogen sulfide gas as the only one developed in the United States with a record of several years' successful operation.

RECOVERY

PETROLEUM GASES

MATHIESON-SASCO
Sulfur Recovery Process



MATHIESON-SASCO PROCESS

A gas stream containing hydrogen sulfide gas, such as the acid gas effluent from an amine plant, is partially burned with air—the heat being utilized for steam production. The combustion gases are passed through a catalyst where SO_2 and H_2S react to form sulfur and water vapor. Elemental sulfur is then recovered from the gas stream by contacting with liquid sulfur in wash towers. The residue gas containing nitrogen, carbon dioxide and water vapor is vented to the atmosphere.

ONE CONTRACT— ONE RESPONSIBILITY

This proven SASCO Process for the profitable recovery of elemental sulfur from waste hydrogen sulfide gas is available under *one* contract, *one* responsibility through The Fluor Corporation, Ltd. As designers, engineers, and constructors for the petroleum industry since 1890, Fluor possesses the background, the know-how and the experience essential for the interpretation of Mathieson's SASCO Process into *your* particular sulfur recovery program. Prior to contract negotiations, Fluor will make economic studies covering every phase of proposed sulfur recovery installations—location of potential and ready markets, initial investment, operating costs, and profits to the investor.

For further information, write:

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Head Wrightson Processes Ltd., London, England

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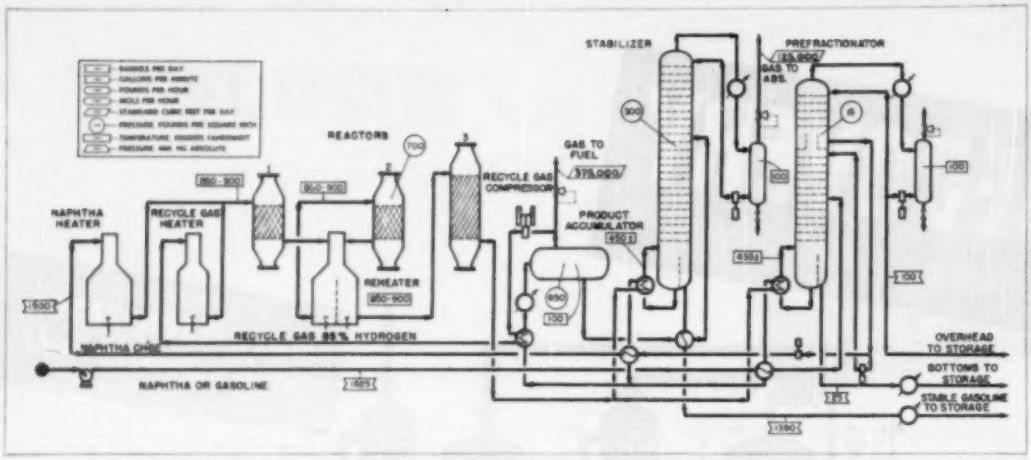


Flow Diagram of Platforming Continuous Catalytic Reforming Process. Heated recycle gas is combined with heated naphtha feed in the process. Inlet and outlet temperatures of third stage reactor are substantially the same, so effluent is used in reboilers and feed heating.

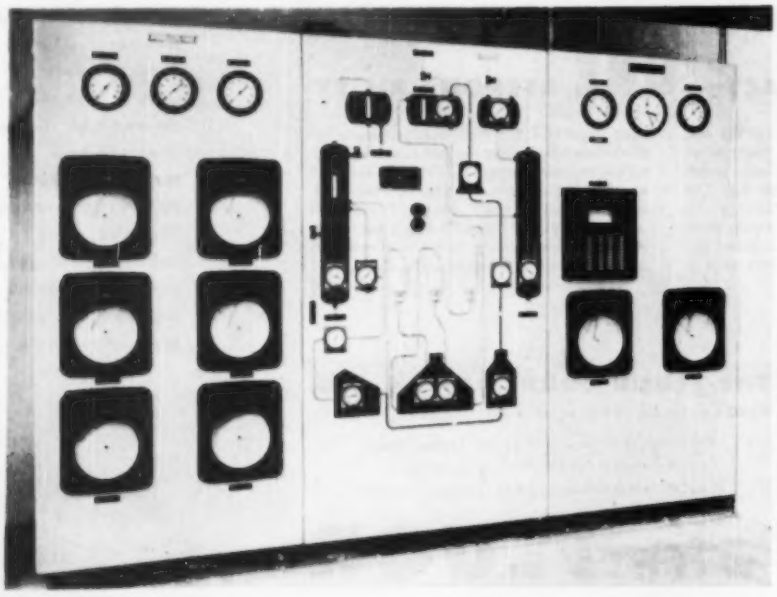
product is excellent.

3) The road performance of Platformate is higher than would be predicted from the laboratory knock ratings, in many cases equaling or exceeding the F-1 octane number.
4) The hydrocarbon composition, isoparaffinic and aromatic, results in a fuel especially suitable for the coming high-compression, high-power automobile engines.
5) Sulfur reduction of 90 percent or more is obtained.
6) The product is as stable as straight-run. Inhibitor is needed only to stabilize the tetraethyl lead.

The accompanying simplified flow diagram is that of a typical Platforming unit for motor fuel production. The unit may be divided into three sections: a feed-preparation section, a reactor section, and a stabilization section.

The *feed-preparation* section consists of a fractionation column taking material boiling in the gasoline range and removing overhead any light gasoline that need not be charged to the reaction zone by virtue of its high octane number. A small amount of bottoms is removed to prevent high boiling material from reaching the catalyst. The reactor charge is drawn from the column as a sidecut. In many cases, existing facilities permit use of a simpler feed-preparation system.

The *reactor section* consists of preheaters for the reactor feed and recycle gas, beds of catalyst, intermediate heaters between catalyst beds, heat



The graphic panel control board has indicating instruments arranged on a process flow diagram to show the principal operating variables and recording instruments to maintain permanent records for bookkeeping and process control needs. The three dials at the top of the left panel indicate pressures of fuel gas, cooling water, and refinery air. The temperature recorders below are used on the naphtha heater outlet, recycle gas heater outlet, stabilizer reboiler, prefractionator reboiler, No. 2 reactor inlet, and No. 3 reactor inlet. Instruments on the right panel show instrument air pressure, the time, plant steam pressure, miscellaneous plant temperatures on the multipoint potentiometer, flows of reactor charge and of recycle gas, and pressures of recycle gas compressor suction and discharge and of stabilizer overhead. A new flowmeter has since been added on this panel to record the flows of prefractionator charge, reflux, and net overhead. The instruments on the center panel flow diagram show liquid levels in reflux drums, product accumulator, and prefractionator sidestream drawoff tray, flows of process streams, heater temperatures, tower temperatures, and so on.

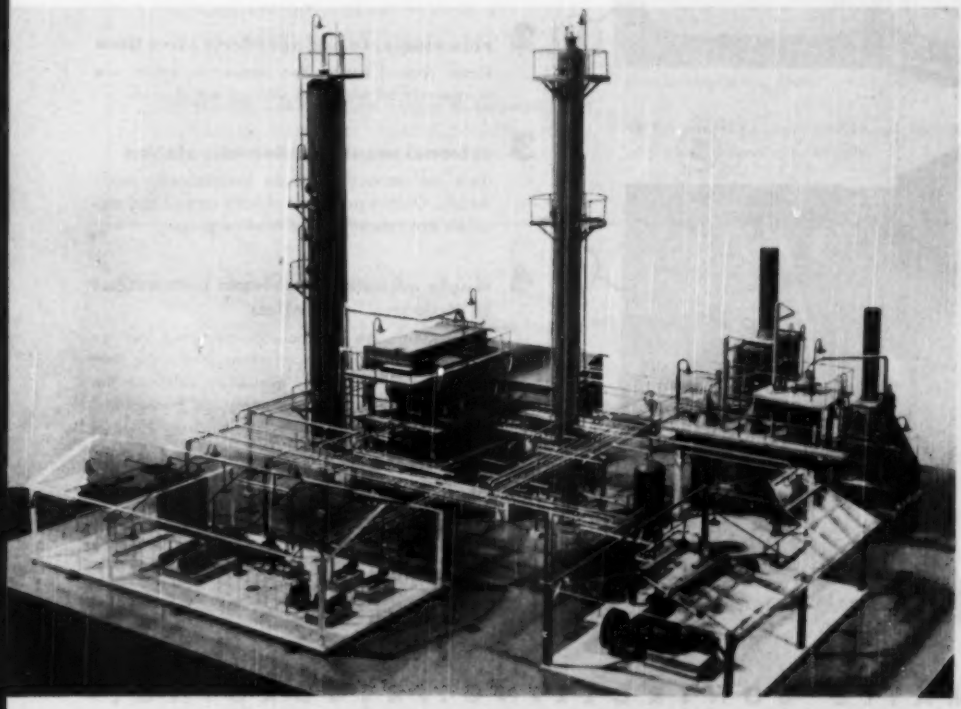
exchangers, a product separator drum, and a recycle gas compressor. Catalyst is divided into two or more beds in series depending on the severity of the operation and on the type of feed stock, with interheating between beds of catalyst, as the overall reaction is endothermic. Reactor feed stock from the feed-preparation section is pumped to the naphtha heater for preheating to reaction temperature.

At the inlet to the first catalyst bed, the heated recycle gas joins with the naphtha. In some cases these two streams are heated in the same coil. The reactants are reheated between catalyst beds by an intermediate heater or heaters. After heat exchange, the reaction products flow to a separator drum from which the recycle gas compressor takes suction. The net make of gas goes to fuel. Liquid product from the separator drum passes to a stabilizer for preparation of a finished gasoline.

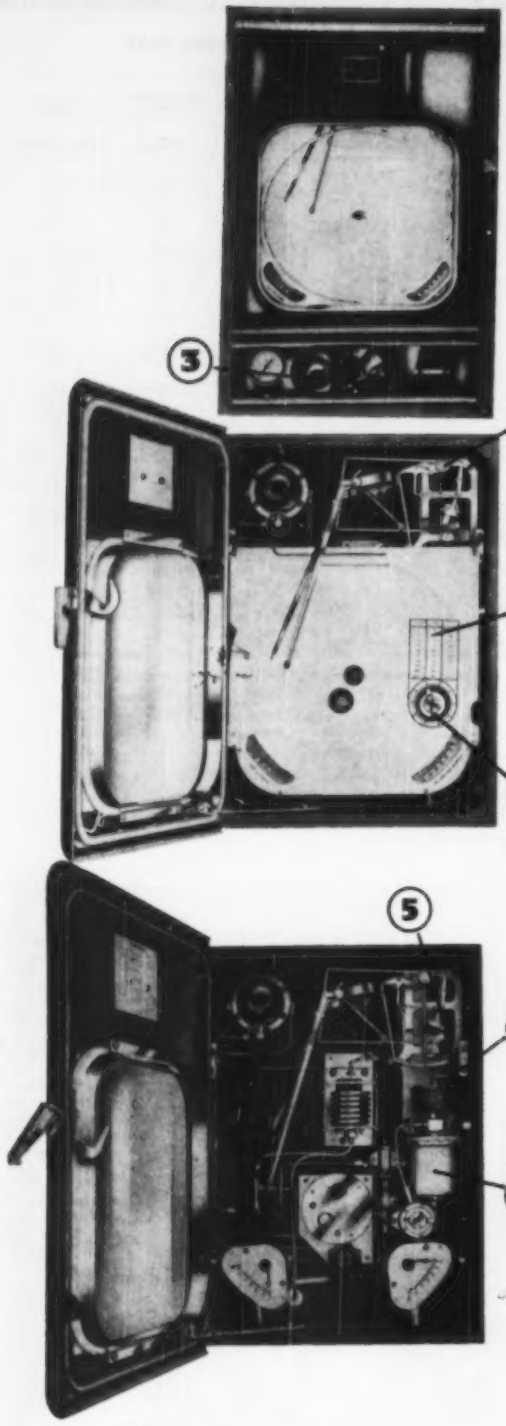
The *stabilization section* consists of a high-pressure stabilizer for production of a finished gasoline of desired vapor pressure from the bottom of the column. Gas from the stabilizer reflux drum enters the absorption system or fuel system as is desired. No rerunning of the stabilizer bottoms is necessary since no high-boiling products are made.

Typical Results from Platforming Various Charging Stocks

	STRAIGHT RUN NAPHTHA						Straight-Run Gasoline		Natural Gasoline	
SOURCE	Mid-Continent		West Texas-Wyoming Blend		California		Michigan		Carthage Field	
Charge Stock:										
°API at 60° F.	54.2		52.0		40.0		64.6		63.2	
RVP	0.4		1.6				4.6		2.5	
Percent Sulfur	0.03		0.26		0.14		0.06		0.02	
Molecular Weight	125		115		120		105		104	
U.O.P. "K"	12.0		11.7		11.6		12.2		12.3	
100 Ml. Distillation:										
I.B.P., °F	182		139		254		120		143	
10 Percent	245		214		273		152		174	
50 Percent	303		289		293		212		223	
90 Percent	365		350		329		293		331	
95 Percent	382		360		339		321		352	
E.P.	402		381		359		360		373	
Octane Rating										
Research Method (F-1)										
Clear	35.0		49.0		58.0		57.5		46.5	
3cc Tel. Gal.	60.5		62.0		74.0		74.0		71.0	
Motor Method (F-2)										
Clear	34.5		45.5		56.5		55.0		44.5	
3cc Tel. Gal.	56.0		61.0		70.5		74.0		70.5	
Platformate										
Yield of C_5-E.P., L.V. Percent	94.5	91.3	96.6	93.7	96.9	93.0	96.1	92.7	97.0	93.0
°API	52.0	53.0	51.1	50.6	44.7	43.2	65.3	66.0	63.8	65.0
RVP	5.0	8.4	4.8	7.8	1.1	2.4	7.3	9.9	6.7	9.9
Percent Sulfur	0.008	0.005	0.014	0.013	0.01	0.01	0.006	0.005	0.002	0.002
110 Ml. Distillation:										
I.B.P., °F.	105	98	110	95	186	152	100	100	105	100
10 Percent	192	177	190	160	258	252	125	117	150	140
50 Percent	285	278	277	265	294	298	195	185	200	190
90 Percent	360	355	350	357	335	343	290	278	300	300
95 Percent	389	387	369	388	345	355	326	328	330	335
E.P.	410	410	393	408	369	390	360	360	385	395
Octane Rating										
Research Method (F-1)										
Clear	74.5	84.5	75.5	88.0	76.0	87.5	72.0	80.0	68.5	79.5
3cc Tel./Gal.	89.0	94.5	87.0	96.0	87.0	95.0	87.0	93.0	87.0	93.0
Motor Method (F-2)										
Clear	69.5	78.5	70.0	80.0	68.5	77.5	69.0	75.5	66.5	75.5
3cc Tel./Gal.	83.5	88.5	90.0	90.0	78.0	84.5	84.5	89.0	84.0	88.5



Model of Old Dutch Platforming Unit Located at Muskegon, Mich. Left to right: Control Room and Pump House, Prefractionating Column, Heat Exchangers and Naphtha Heater and Product Stabilizer Column. Right foreground to right rear: Recycle Gas Compressors, Three Reactors and Intermediate Heaters. (Note flow chart on opposite page.)



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Reset rate, derivative time and proportional band adjustments are calibrated and exactly reproducible.

2 zero reset rate and zero derivative time

Reset control action and derivative action are *completely off* when the settings are at zero.

3 external manual-automatic station

Test and service positions mechanically interlocked. Output pressures of both control and regulator are measured by the *same* gauge.

4 single adjustment returns instrument to "control" operation

Components are so accurately designed and are manufactured under such close tolerances that only one adjustment is needed to calibrate the control system after disassembly and reassembly.

5 gold-plated free vane

Made of beryllium copper for strength, gold-plated against corrosion.

6 resets stops

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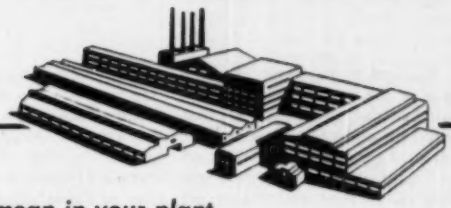

Here's what these exclusive features mean in your plant

1 Calibrated control saves you hours of shut down time. Enables you to duplicate previously-established control actions exactly without cut-and-try... and to standardize controller adjustments for any process throughout an entire plant or national organization.

2 Zero reset and zero derivative time facilitate adjustments and start-up. Positive zero is useful during initial band and rate adjustments, testing and automatic start-up.

3 Mechanical interlock makes it impossible to accidentally go through "manual" to either "test" or "service." *Single gauge permits exact balancing of control and regulator pressures* before switchover—thus eliminating danger of "bumping" the process.

4 Almost anyone can service a Series 500 Controller. Even with replacement parts, a single adjustment puts the instrument back in exact calibration.

5 Absolutely true measurement. Control mechanism is operated by gold-plated "free vane" which imposes no retarding effect on measuring element. Made of beryllium copper, it is stronger, stays flat and in alignment, cannot be damaged in cleaning.

6 Reset stops. Ask the Bristol representative to explain this exclusive feature.

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New Houdriflow Installations Employ Modified Design

HOUDRY PROCESS CORPORATION
Philadelphia, Pennsylvania

THE EARLY moving bed catalytic cracking plants utilized bucket elevators for raising catalyst to overhead hoppers whence the catalyst was routed to reactor or regenerator under gravity flow. Many such units were built and most of them continue in commercial operation. Development work on moving bed catalytic cracking processes in recent years has been directed at the perfection of catalyst handling systems that use gas or vapor as the lifting medium for catalyst elevation instead of the older mechanical elevators. Units embodying such principles are now in commercial operation and others are under construction.

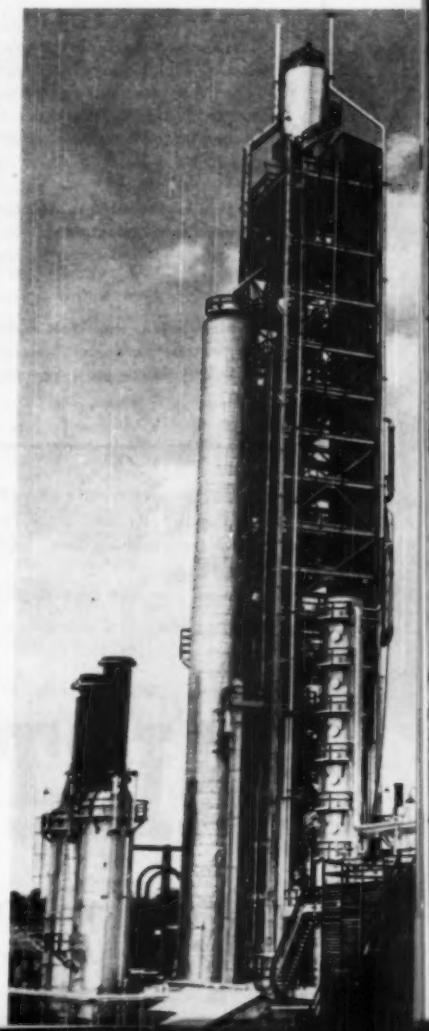
THE Houdriflow catalytic cracking process is of the moving-bed type and therefore has the advantages of true countercurrent and concurrent flow of reactants and catalyst in all reaction vessels. This feature insures uniform contacting of catalyst and charge oil in the reactor for optimum yields and product distribution and promotes long catalyst life by preventing by-passing of individual catalyst pellets in the regenerator or kiln.

In this respect, it is similar to the older TCC process also licensed by Houdry Process Corporation. Houdriflow differs from TCC, however, in that the reactor and kiln are superimposed in a single self-supporting structure, the internal design of the kiln is greatly simplified due to the maintenance of higher catalyst circulation rates and transportation of the catalyst from the bottom of the kiln to the top of the reactor is accomplished by means of a gas lift instead of a bucket elevator.

The flow diagrams illustrate the original Houdriflow design, first announced about two years ago, and the modified Houdriflow design of which several commercial installations are being made. The principal innovations of the modified design are: 1) the elimination of an intermediate seal leg between the reactor and kiln which greatly simplifies vessel design and effects a substantial reduction in unit height; 2) the elimination of pressure balance between the reactor and kiln by a redesign of the kiln such that the pressure at the top of the kiln is essentially atmospheric; 3) a new, simplified type of catalyst and vapor disengager located in the bottom of the reactor; and 4) the use of relatively inexpensive thermo-compressors to compress the portion of the kiln flue gas utilized in the lift, thereby permitting the use of a single stage blower for furnishing regeneration air to the kiln.

Pelleted or spherical bead catalyst flows by gravity from the lift disengaging hopper through the reactor seal leg into the top head of the reactor. Approximately 75 percent of the flowing catalyst stream enters the reactor proper by way of a falling annular curtain of catalyst which is an integral part of the oil charge injection system. The balance of the catalyst enters the reactor via a circle of catalyst feed pipes located near the shell of the reactor. These pipes establish the depth of catalyst bed in the reactor. Leaving the reaction zone, catalyst continues to flow by gravity through the new vapor disengaging section located at the swaged portion of the reactor shell, through a conventional Houdriflow steam purge section into the top head of the kiln. As shown in the flow diagram, the dished head in the top of the kiln carries a large number of straight seal pipes which serve to introduce catalyst into the top zone of the kiln, distributing it uniformly over the cross section of the kiln, and also to provide a means of sealing between kiln gases and the hydrocarbon system. In the design illustrated, the kiln has two countercurrent burning zones with an intermediate cooling zone. Catalyst then flows through a new type, conical draw-off section and through the kiln outlet seal leg into the lift engaging hopper from which it is transported pneumatically to the lift disengaging hopper to complete a cycle of flow.

The preparation and handling of charge oil and products in the latest Houdriflow system is the same as that employed in earlier designs. Normally, the charge is preheated to such a degree that it is introduced in a mixed phase. However, with appropriate design for balancing heat generation and absorption, total liquid or completely vaporized charge streams may be proc-



Houdriflow catalytic cracking unit at the Drumright, Oklahoma refinery of Tide Water Associated Oil Company. Nominal capacity is 6750 barrels per stream day.

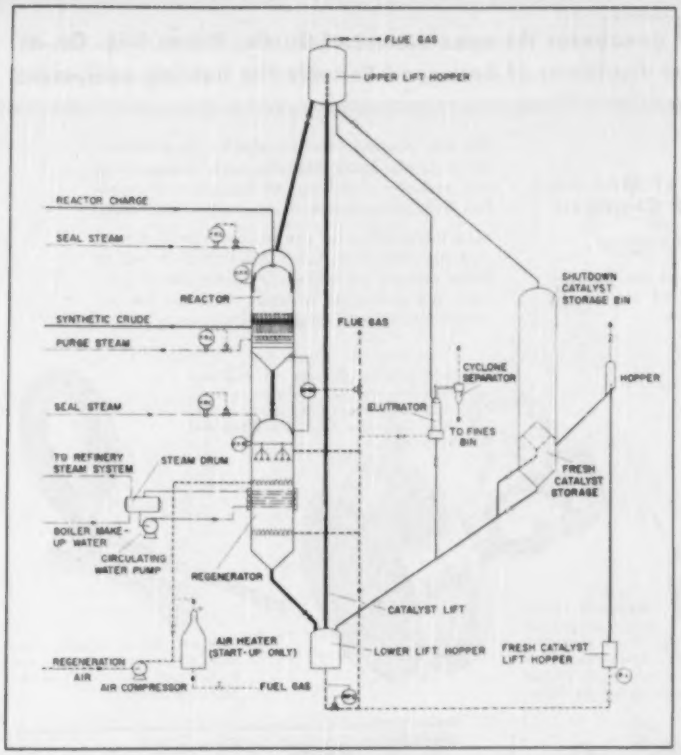


Figure 1. Flow diagram showing the original design of the Houdriflow catalytic cracking process.

essed. Mixed phase feed is introduced through a new and simplified distributing nozzle located centrally within the annular curtain of catalyst at the top of the reactor, and vaporization and initial cracking of the charge occurs when it is contacted with the curtain of catalyst. The cracking reaction is completed as the hydrocarbon vapors flow downward through the solid bed reaction zone. Cracked vapors or synthetic crude are separated from the catalyst in the new disengaging section and collected in an annular plenum chamber formed by the swaged outer shell at the bottom of the reactor and a continuation of the straight portion of the reactor shell. Vapors leave this plenum chamber and pass to a conventional fractionation and gas recovery system.

Regeneration air is supplied by a single stage blower at 4 to 5 psig. pressure in the modified Houdriflow design. The distribution of air flow between the two burning zones may be adjusted to suit particular regeneration requirements. The pressure drop relationships in the burning zones are such that the highest kiln pressure exists at the inlet to the lower zone while the top of the kiln is at essentially atmospheric pressure.

For example, coincident with a blower discharge pressure of 4 psig., the pressures at various points in the kiln would be approximately as follows: 3.5 psig. at the inlet to the lower zone, 2 psig. at the outlet of the lower zone, 2 psig. at the air inlet to the upper zone and 0.3 psig. at the outlet of the upper zone. This arrangement permits by-passing of the oil charge around the reactor without disturbing the normal operation of the kiln and the lift.

Located intermediate between the two burning zones is a bank of cooling coils, the use of which may be adjusted to extract regeneration heat as required to maintain desired degeneration temperatures. A portion of the flue gas from the lower burning zone is compressed by a thermo-compressor to the pressure required to motivate the lift, nominally 5 to 6 psig. Another small portion of the lower zone flue gas is diverted to the elutriator for continuous classification of the system catalyst and the removal of "fines." The remainder of the flue gas from the lower zone and all of the flue gas from the upper zone is vented to the atmosphere through the kiln stack. A direct-fired air line burner is provided in the air line to the kiln or heating the system prior to going on stream.

Low-pressure steam is introduced into the unit at several places as an inert sealing medium. For example, steam is introduced into the head of the reactor and flows up the reactor seal leg preventing the escape of hydrocarbon vapors from the reactor into the lift disengager. Steam introduced beneath the purge plate in the bottom of the reactor serves two functions; a portion flows upward through the purge nipples stripping spent catalyst of residual hydrocarbon while the remainder flows downward through the seal pipes into the outlet of the upper burning zone of the kiln preventing the flow of flue gas into the distillation system. Since the designed compression ratio of the thermocompressor is low, the steam consumption of this device is relatively insignificant. Normally, 150 psig. steam will be used as the motive fluid in the thermocompressor.

Commercial Houdriflow installations incorporating these latest design features are under construction for Salt Lake Refining Company, California Refining Company and Shamrock Gas and Oil Corporation. Salt Lake Refining Company's unit at Salt Lake City, Utah, has a design charge capacity of 13,000 barrels per stream day with a nominal catalyst circulation rate of 300 tons per hour. Twin units, each of which is rated at 12,500 barrels per stream day, are being erected for California Refining Company at Perth Amboy, N. J. The catalyst circulation rate for each of these units is 425 tons per hour. The Shamrock unit at McKee, Texas, is rated at 11,000 barrels per stream day capacity with a catalyst circulation rate of 300 tons per hour.

Several commercial installations of the original Houdriflow design are now either operating or under construction. Illustrative of this design are the four units in Sun Oil Company's refinery at Toledo, Ohio, and Tide Water Associated Oil Company's unit at Drumright, Okla. The Sun installations consist of four reactor-kiln sections with individual gas lifts in a common structure. In order that the principal vessels in this unit might be shop fabricated, the diameters of these vessels were limited to a maximum of 12 feet. This plant has a single feed preparation, distillation and gas recovery section for all four catalytic

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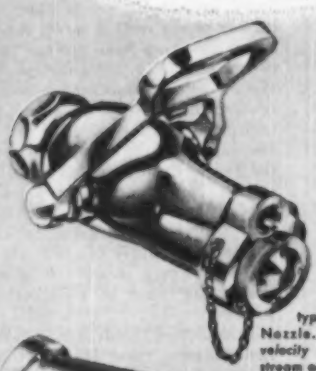


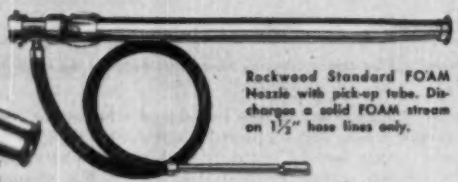
Rockwood LIGHTweight triple-action type SG-48 WaterFOG Nozzle. Discharges high velocity WaterFOG, straight stream or low velocity WaterFOG.

New LIGHTweight Type FFF Rockwood FogFOAM Nozzle. Available in three sizes for service on 1½", 2½" or 3½" hose. Discharges FogFOAM, FOAM and WaterFOG.

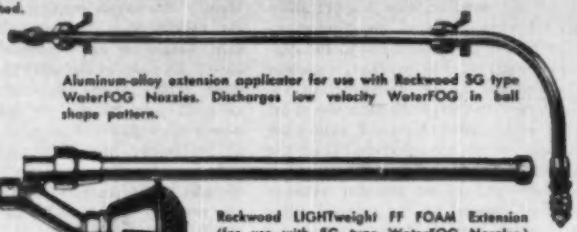
Rockwood FOAM eductor introduces FOAM Liquid into hose line for use with Rockwood type FFF FogFOAM Nozzles.

Rockwood LIGHTweight Type B, 500 GPM, High Capacity WaterFOG Nozzle for use on deluge guns, ladder pipes, etc.

Rockwood LIGHTweight type FFF FogFOAM Nozzle with FOAM shaper attached.



Rockwood Standard FOAM Nozzle with pick-up tube. Discharges a solid FOAM stream on 1½" hose lines only.



Aluminum-alloy extension applicator for use with Rockwood SG type WaterFOG Nozzles. Discharges low velocity WaterFOG in ball shape pattern.

Rockwood LIGHTweight type N-23 WaterFOG Nozzle with swivel handles.

Rockwood LIGHTweight FF FOAM Extension (for use with SG type WaterFOG Nozzles.) Rockwood FF Extension can be easily attached to a ¾" or 1" and 1½" SG type WaterFOG Nozzle. Discharges FogFOAM and Solid FOAM Stream.

Rockwood LIGHTweight swivel handle play pipe available in 1½" and 2½" sizes for all Rockwood Nozzles.

Rockwood LIGHTweight ball type shut-off for use on 1½" and 2½" fire hose lines.

Rockwood FF FOAM Extension attached to SG Type WaterFOG Nozzle.

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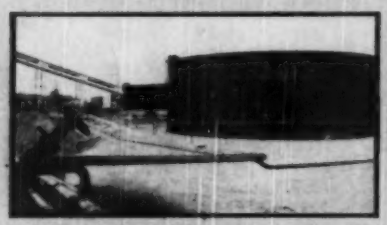
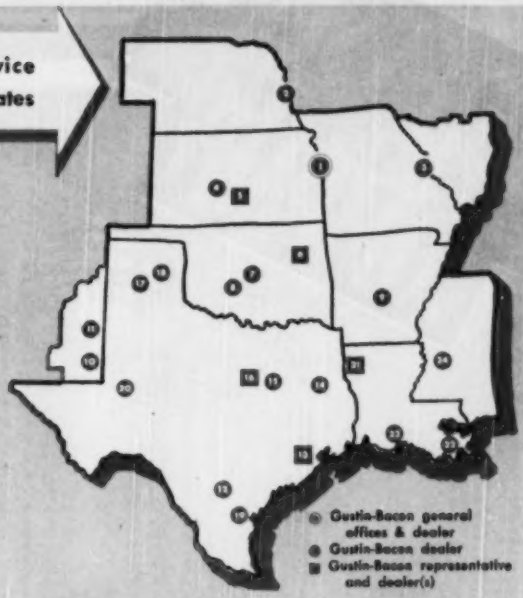
Rockwood FOAM. A mechanical liquid type FOAM for producting FOAM and FogFOAM for use in extinguishing fires.

Rockwood "Wet". Wetting agent or penetrant to be mixed with water for fighting fires.



Tank farm at a large electric power generation station protected with Rockwood fixed FOAM systems. The tank in the foreground is a 150,000 barrel steel tank (150' diameter by 48' high).

For wholehearted cooperation in working out your fire-fighting problems, get in touch with your nearest Gustin-Bacon District Office — in Tulsa, Ft. Worth, Houston, Shreveport or Wichita. Complete stocks of Rockwood fire-fighting materials will be warehoused in Kansas City and Houston. The 24 Gustin-Bacon dealers shown on the map have stocks of foam, wet, and nozzles, and they're ready, willing and able to give you service on Ansul, as well as Rockwood equipment.



1. Kansas City, Mo: G-B General Offices
   Safety, Inc.
2. Omaha, Nebraska: Cardinal Supply & Mfg. Co.
3. St. Louis, Mo: Safety, Inc.
4. Great Bend, Kansas: C. W. Cotton Supply Co.
5. Wichita, Kansas: Mid-Continent Transmission & Supply Co.
   G-B Representative
6. Tulsa, Oklahoma: Eustice Equipment Co.
   W. L. Walker Co.
   G-B Representative
7. Oklahoma City: Fire Appliance & Supply Co.
8. Chickasha, Okla: Chickasha Gin Supply Co.
9. Little Rock, Ark: Fire Appliance & Supply Co.
10. Hobbs, New Mexico: Union Supply Co.
11. Artesia, New Mexico: Union Supply Co.
12. San Antonio, Tex: Alamo Extinguisher Co.
13. Houston, Tex: Allied Safety Equipment, Inc.
    G-B Representative
14. Longview, Tex: Baxter Sales Co.
15. Dallas, Tex: Fire Equipment Service Co.
16. Ft. Worth, Tex: Fire Extinguisher Service Co.
    G-B Representative
17. Amarillo, Tex: Radcliff Supply Co.
18. Pampa, Tex: Radcliff Supply Co.
19. Corpus Christi, Tex: Southwest Equipment Co.
20. Odessa, Tex: Vaughn & Co.
21. Shreveport, La: McGriff Sales Co.
    G-B Representative
22. New Orleans, La: Delta Fire & Safety Equipment Co.
23. Lafayette, La: Delta Fire & Safety Equipment Co.
24. Jackson, Miss: Safety Engineering Service Co.

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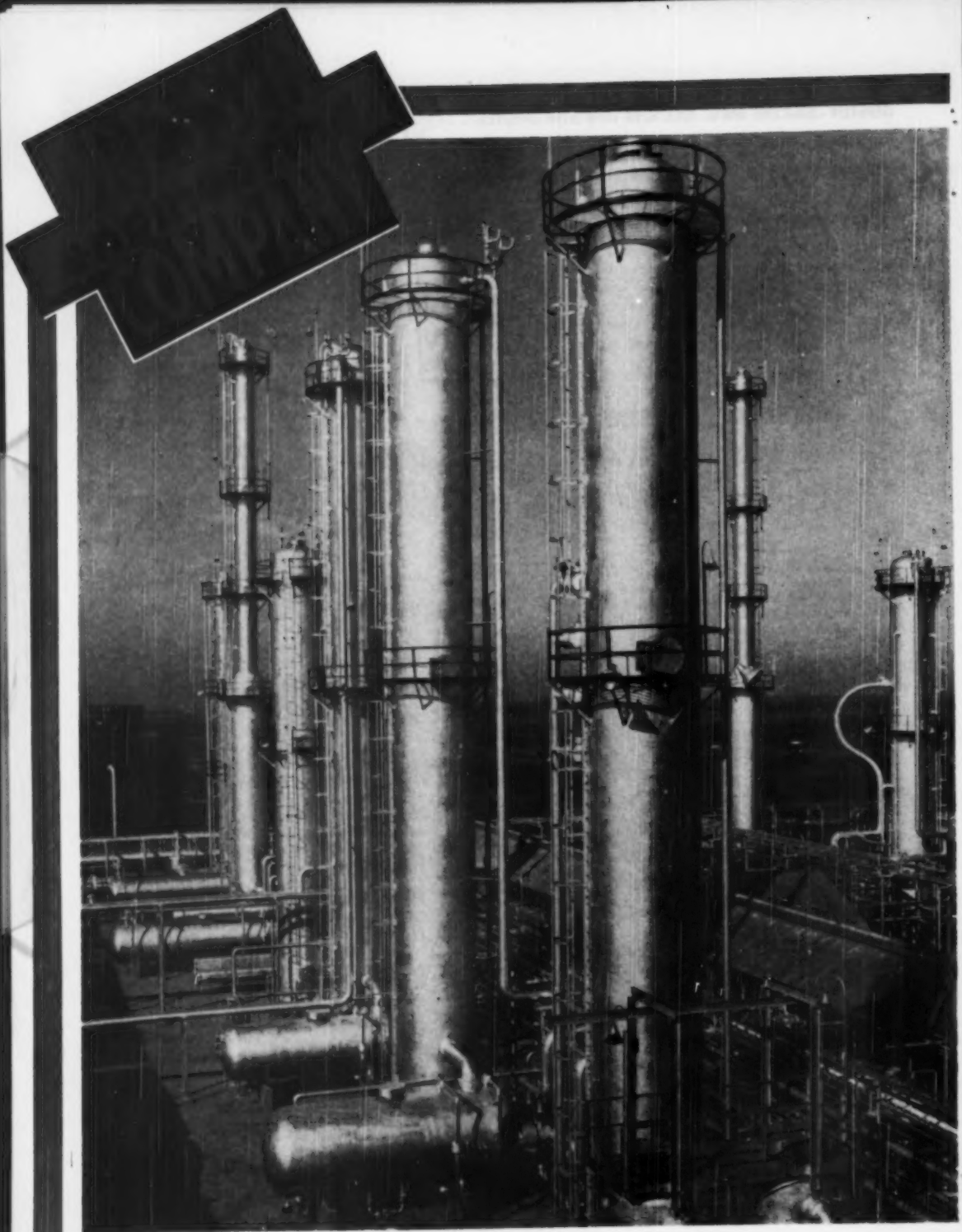

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sections. There are two regeneration air blowers, each serving two catalytic sections. This arrangement provides considerable operating flexibility. The ability to shut down one portion of the system without shutting down the entire plant is another advantage. This plant was put into operation several months ago charging atmospheric and vacuum gas oils from Mid-Continent crude. The design charge capacity of each reactor is 7500 barrels per stream day; therefore the plant has a nominal processing capacity of 30,000 barrels daily.

The catalytic section of the Tide Water unit is similar to each of the reactor-kiln sections of the Sun plant. There are, however, certain significant differences. For example, the reactor-kiln section of the Tide Water unit was not limited to the 12-foot diameter rail shipping dimension, the reactor being 14 feet in diameter and the kiln 18½ feet in diameter. The nominal capacity of this unit is 6750 barrels per stream day and the design catalyst circulation rate is 250 tons per hour. Another Houdriflow unit of essentially the same design is presently under construction for Petco Corporation at Blue Island, Ill.

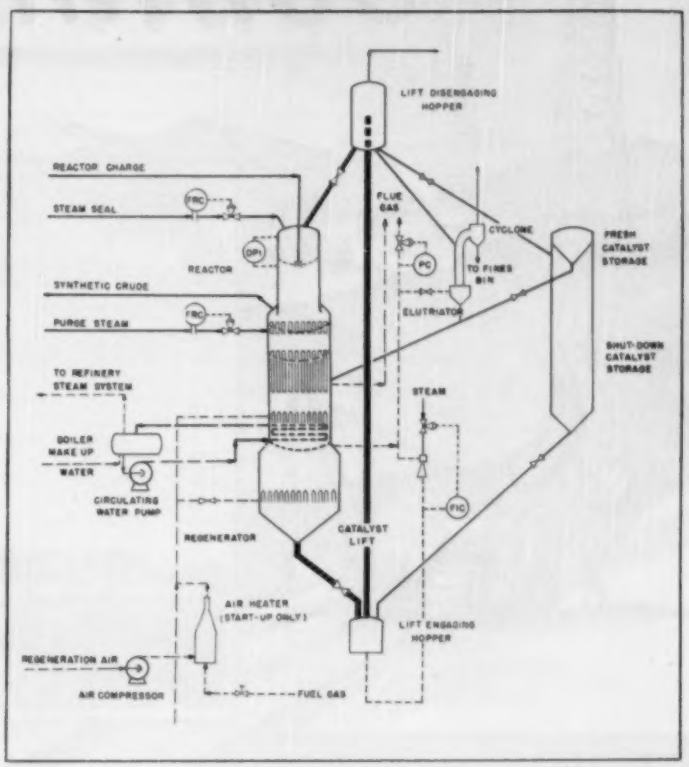
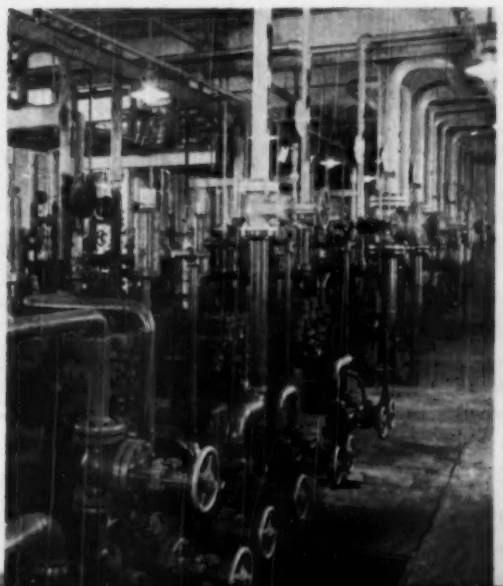


Figure 2. Flow diagram showing the Houdriflow process as modified in current designs.

Pumproom of unit at the Tide Water Refinery at Drumright.



Houdriflow installation at the Toledo, Ohio Refinery of Sun Oil Company. It includes four reactor-kiln sections with individual gas lifts in a common structure. Thruput is 30,000 barrels per day.

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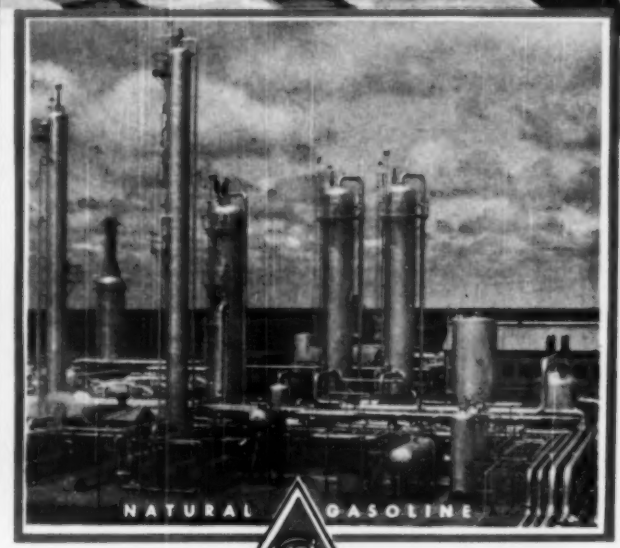

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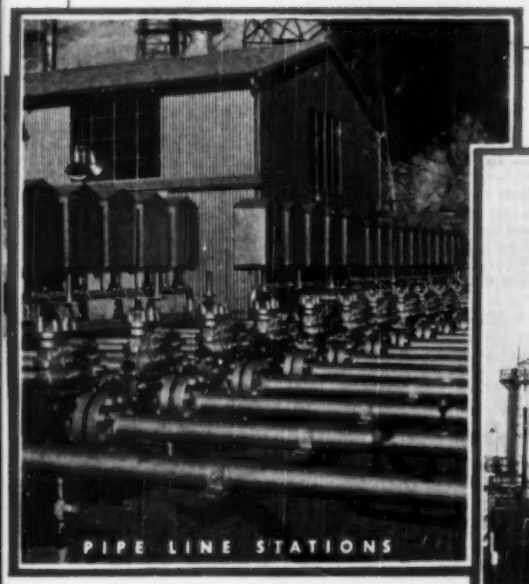

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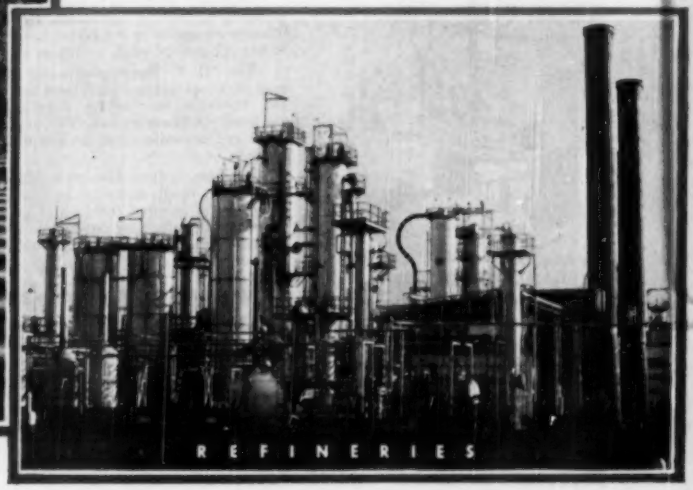

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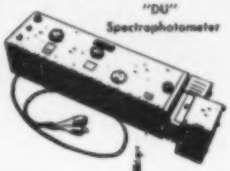

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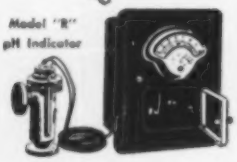

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Socony-Vacuum TCC Units Move Catalyst by Gas Lift

ARTHUR V. DANNER
Socony-Vacuum Oil Company, Inc.,
New York, New York

THE 1951 design of the Socony-Vacuum TCC unit incorporates the results of operating experience from nearly 40 TCC units (in the refineries of Socony-Vacuum and other companies) and ten years of research and development on moving-bed catalytic cracking. Improvements in mechanical design have materially reduced investment costs and plot areas, by simplifying regeneration and catalyst elevation equipment. At present there are nearly 20 of these units authorized or under construction, both in Socony and in refineries of outside companies, all licensed directly by Socony. These units, ranging in size from 1500 to 30,000 barrels per stream day charge capacity, all are designed from the same basic flow diagram, Figure 2, although their outside appearance may differ.

THE TCC PROCESS has been revised through the substitution of a gas lift for the bucket elevator system used in the earlier units. This change allows higher circulation of catalyst, providing higher catalyst-to-oil ratios. Higher catalyst flow rates simplify regenerator design since fewer "burning zones" are needed due to the greater heat capacity of the larger catalyst flow. Also, greater flexibility in heating the oil charge to the reactor is obtained. The new design has been applied to units of a considerable range of sizes and several plants are now under construction.

Since the feed preparation, fractionation and gas recovery systems associated with this catalytic cracking unit are of conventional low pressure design (similar to a simple crude distillation system) this discussion will be confined to the catalytic cracking section alone from the kiln to the reactor.

As shown in the flow diagram, Figure 2, oil from the feed preparation system enters the top of the reactor and contacts hot regenerated catalyst. The oil is cracked under a pressure of about 10 psig. at temperatures in the range of 850 to 925° F. while passing downward concurrently through the moving bed of catalyst. The cracked vapors are disengaged from the catalyst and flow to the fractionating system. The spent catalyst is then thoroughly purged of heavy hydrocarbons by steam flowing countercurrently (upward) to minimize the regeneration load on the kiln and increase the liquid recovery. The spent catalyst is withdrawn from the reactor through a drawoff system which maintains a uniform catalyst flow in the reactor.

In TCC operations the amount of hydrocarbons (measured by solvent extraction) left on the purged spent catalyst going to the kiln for regeneration is always nil.

Upon leaving the reactor, the purged spent catalyst flows through exterior pipes equipped with shutoff safety valves to the kiln for regeneration. These valves normally remain open since they are not used to control flow rates. They are purely safety valves to keep air from entering the reactor and oil from leaving it should there be an emergency. The catalyst entering the kiln flows through a distributor which maintains a uniform catalyst size in all portions of the kiln. The kiln operates at essentially atmospheric pressure. Hence, low-pressure air is used for regeneration. This low-pressure air enters the catalyst bed near the middle of the kiln, and flows both countercurrently upward and concurrently downward. The portion flowing upward (countercurrently to the catalyst) burns approximately 60 percent of the coke and the flue gas leaves the kiln between 850 and 900° F., (within a few degrees of the entering catalyst). The entering catalyst is heated by the combustion of the coke to between 1150° and 1250° F. and then cooled about 200° F. by the entering regeneration air. The regeneration of the catalyst is completed in the bottom section of the kiln by air flowing downward (concurrently with the catalyst) raising the catalyst temperature to approximately 1250° F. (1150° F. for clay catalyst). The catalyst is then cooled to the temperature desired for accomplishing the cracking reaction, by passing over cooling coils through which water is circulated. This heat removed in controlling the catalyst temperature in the regenerating zone generates steam at a pressure suitable to the refinery needs. Regenerated catalyst leaves the kiln at the temperature desired for it to return to the reactor.

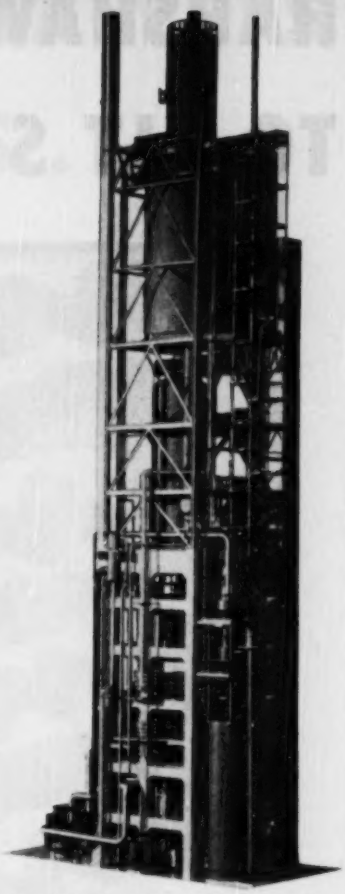

Figure 1. Scale model of 15,000 barrel per day TCC unit having a gas lift system for elevating the catalyst which moves down through the reactor and regenerator under gravity flow.

The regenerated catalyst then flows from the bottom of the kiln to a lift pot, from which it is transported by lift gas to the top of the unit. The desired catalyst flow rate may be

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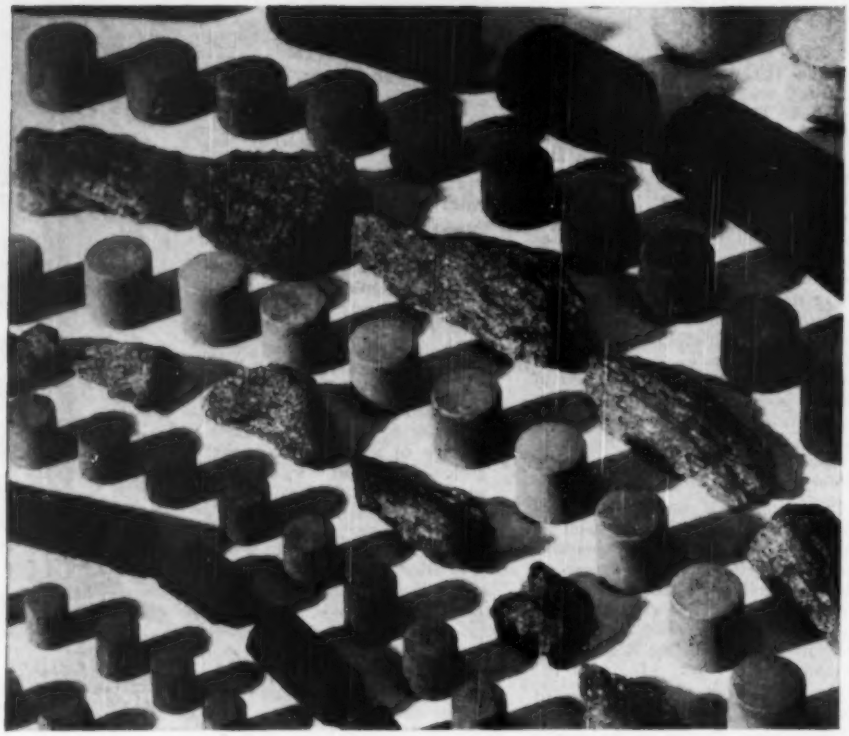

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readily attained by manipulation of the flow rate of the lift gas. Low-pressure air is used for the lift gas. Since the catalyst in the entire system (except for the lift line) is a continuous solid bed, the flow through any portion of the unit depends on rate of withdrawal of catalyst in the portion below. Therefore, if 100 tons per hour of catalyst is lifted to the separator-surge drum at the top of the unit, 100 tons per hour will move through the kiln, and 100 tons per hour through the reactor. The Socony TCC unit is so designed that (at any rate of catalyst circulation) there will be a uniform flow of catalyst at any lateral cross-section, although these may be a 50-fold variation in vertical flow rate at different elevations of the unit. Years of fundamental development work on flow characteristics of moving beds of solid particles has given Socony a wealth of "know-how" in this essential art for the designing of TCC units.

When the catalyst and lift gas reach the top of the unit, the lift gas is disengaged from the catalyst and vents to the atmosphere. The catalyst then flows down through a vertical seal leg to the reactor. Steam flows upward (countercurrently to the catalyst) through this seal leg to accomplish two purposes: 1), it prevents oil from leaving the reactor or air from entering the reactor with the catalyst and 2) the pressure drop of the steam passing upward enables the catalyst to leave the separator-surge drum at atmospheric pressure, and to enter the reactor at the desired pressure of about 5 to 15 psig. This pressure is set by the pressure necessary to push the reactor effluent through the fractionation system. Upon entering the reactor the catalyst has completed its circuit of the system and is ready to start through again.

The Socony TCC unit is composed of three sections, any of which may be operated at a different pressure and temperature without simultaneously changing the pressure or temperature of the other two sections. For example, the reactor conditions may be varied over a pressure range of 0 to 15 psig., and the temperature from 800° to 950° F., to fit the optimum cracking conditions for various charge stocks without disturbing the optimum regeneration temperatures (described previously) which are maintained constant with no pressure variation, and the catalyst lift will also be operating at constant pressure conditions.

Beside the main vessels described above additional equipment included in the catalytic section are: low-pressure blowers (single stage centrifugal) to supply air for regeneration and catalyst lift; a steam drum to separate the steam generated in the kiln cooling coils from the circulating water; air heaters in which lift and regeneration air may be heated by direct combustion of fuel to provide additional operating flexibility; storage bins for fresh catalyst, catalyst in the system, and fines; an "elutriator" or classifier to separate the fines (worn particles of catalyst) from the full size catalyst; and a small elevator for the fresh makeup catalyst.

Figure 1 is the picture of a scale model of Socony's 1951 design to be installed at its Trenton, Mich. refinery. This unit has a design capacity of 15,000 barrels per stream day fresh feed.

Small Size Units

In addition to the 1951 TCC design worked out for larger size units, Socony has recently engineered a 1951 "package" TCC design for units having total charge capacities below 6000 barrels daily. This "package" design employs the same moving-bed principles and the same gas lift for catalyst as are used in the design for larger units.

An objective of the "package" TCC design was to provide a TCC unit for the smaller capacity ranges which would have an investment cost per barrel of capacity in line with the investment cost per barrel of capacity for larger TCC units. To help attain this objective all vessels of the "package" units have been so designed that they can be shop fabricated and shipped to the plant site by railroad. In fact, all items of equipment can be prefabricated so that the job at the plant site can be one primarily of field erection rather than field construction. Time and cost of field erection for the "package" TCC units have been further reduced by employing a standard, but specially-braced, oil field derrick for the TCC structure. This derrick is used to lift the vessels into place during the period the plant is being built and hence eliminates the need for bringing heavy rigging equipment into the field.

On the facing page is a picture of a scale model of a 3000-barrel-per-stream-day capacity package unit, including all equipment for feed preparation, fractionation and stabilization systems as well as the catalytic cracking section.

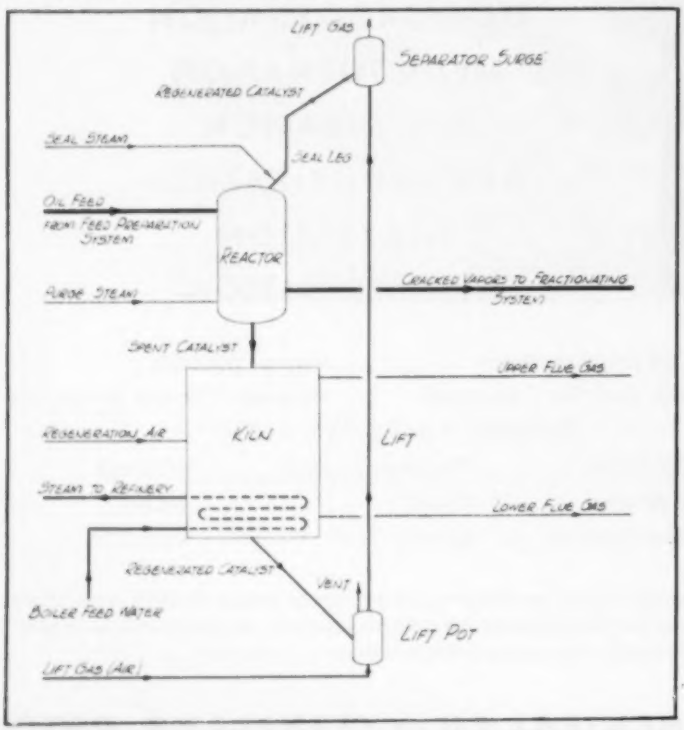


Figure 2. Diagram of reaction, regeneration, and catalyst lift section of TCC process. The oil is cracked under a pressure of about 10 psig, at temperatures in the range of 850 to 925° F.

TCC Units Designed for Small Refineries

SOUTHWESTERN ENGINEERING COMPANY
Los Angeles, California

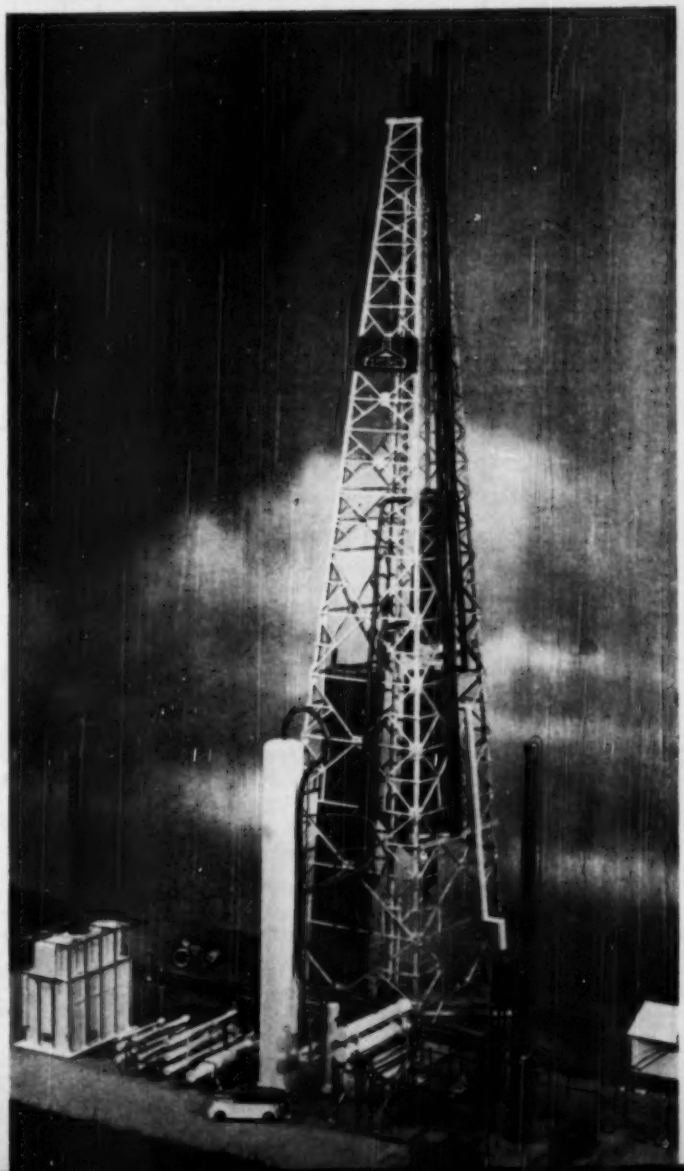
THE MAJORITY of the catalytic cracking units that have been built are of comparatively high thruput. Early plants were quite complex and required heavy capital investment which could only be justified by large volume operations. The catalytic cracking processes have much to offer in small refinery applications, and simplifications and improvements in their design must inevitably lead to their extensive application in refineries of all sizes. Much has already been accomplished along these lines. This article describes a series of small plant designs based on the TCC process.

THE economics of refining have in the past several years made it increasingly difficult for the small refinery to keep pace with the high-octane requirements of the gasolines being marketed by the industry.

Recognizing the need for catalytic cracking facilities designed for small thruputs, Southwestern Engineering Company, Los Angeles, has joined forces with Socony Vacuum Oil Company of New York in the design and construction of two packaged Thermofor catalytic cracking plants of small size. These units cover a range of thruput varying from 1000 to 3000 barrels daily, the smaller plant having a nominal capacity of 3000 and the larger 6000 barrels. A limited plot size is required, an area approximately 150 by 200 feet being sufficient for an entire plant.

The "packaged" feature offers a plant completely shop fabricated for final assembly at the plant site by field erection crews.

A complete plant is composed of three units: 1) feed preparation, 2) catalytic section, and 3) stabilization. The feed preparation section consists of a fired heater, tar separator and synthetic crude tower. The catalytic section is composed of TCC reactor, regenerating kiln, lift pot, lift pipe, catalyst-air separator, catalyst cooler and catalyst storage. The stabilization section consists of stabilizer, compres-



A standard oil field derrick, suitably reinforced, serves as the support structure for this "package type" catalytic cracking unit. All vessels, the furnace, piping, control house, and the derrick are shop fabricated. The field work is thus reduced to foundation construction and process equipment assembly.

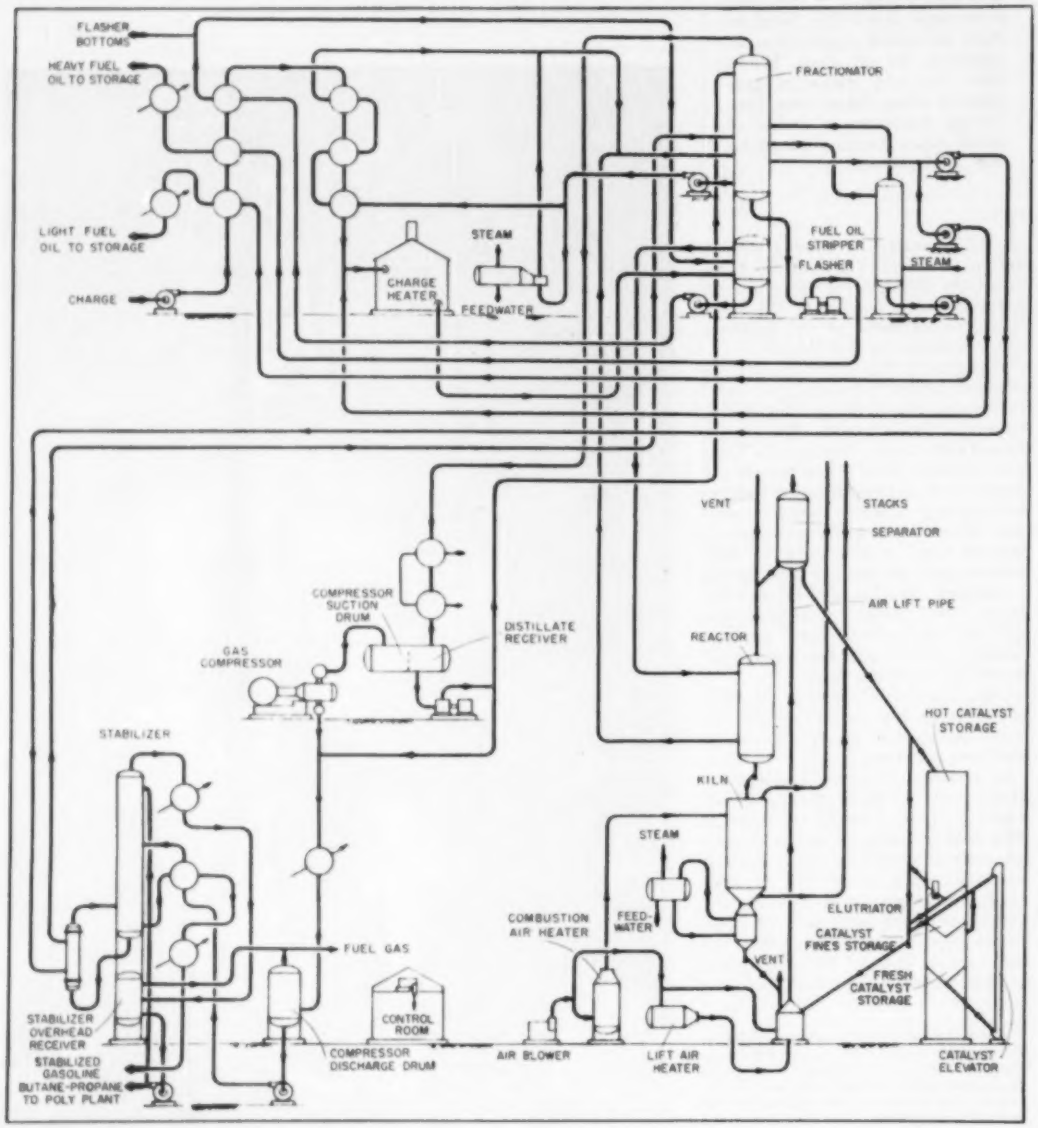
sor and heat exchangers.

In addition to the three units, the plant includes control house, semigraphic control panel, compressor building and all auxiliaries such as pumps, blowers, heat exchangers, reflux drums, piping, supporting structures, foundations etc. A unique feature of the catalyst section is the utilization of a standard type derrick supporting the various components of which the TCC unit is comprised. All equipment has been designed to resist corrosion resulting from sour charge stocks.

Permissible charge stocks range from reduced crude to light gas oil.

The process consists of conventional feed preparation with the charge being vaporized in the feed heater. The heavy unvaporized portion is removed in a tar separator and may then be used as a liquid feed to the reactor. The overhead vapor from the tar separator forms the primary feed to the reactor. Effluent gases from the reactor are quenched and fed directly to the synthetic crude tower where gasoline is recovered overhead and other desired fractions separated in side strippers and as bottom product. The unstabilized gasoline from the synthetic crude tower is then fed to the stabilizer where the desired vapor pressure is established.

Flow diagram of "package type" catalytic cracking unit. In addition to the catalytic section comprising reaction and catalyst regeneration apparatus, the plant also includes a charge heater and flash drum for feed preparation and distillation and stabilization columns for the reactor products.



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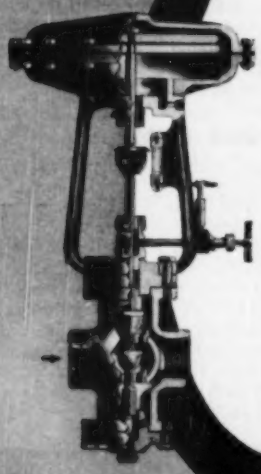

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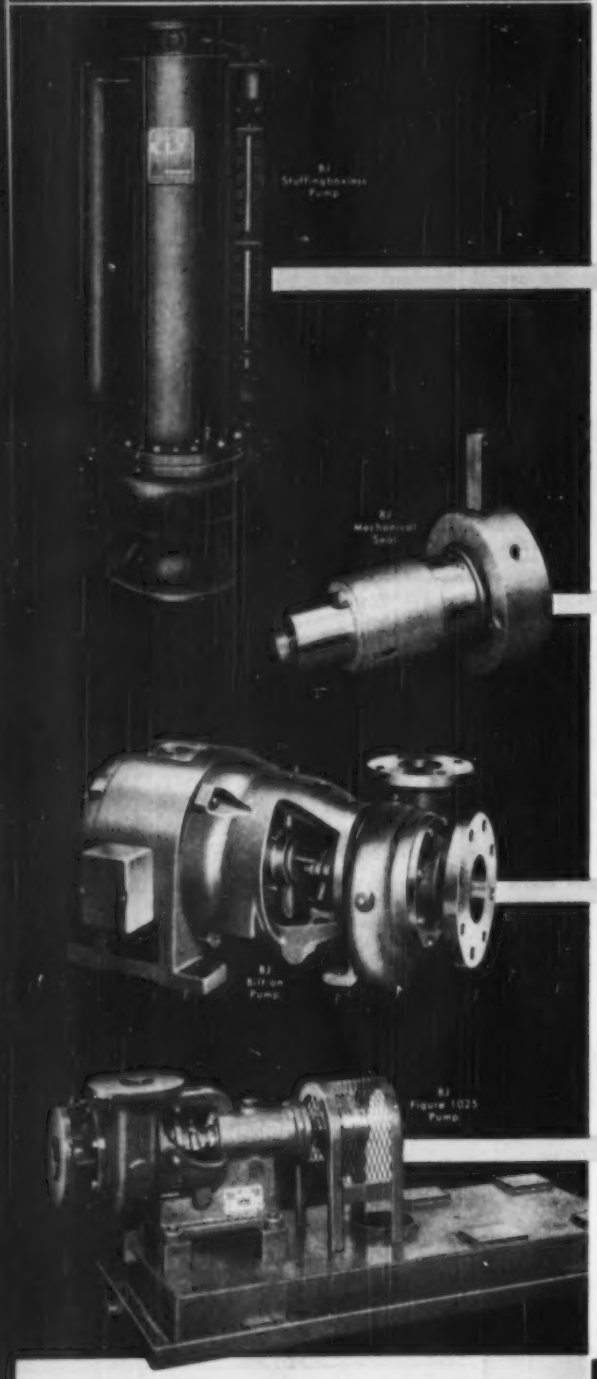

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FIGURE 1025 PUMP

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Designed for handling liquids—hot or cold—corrosive or non-corrosive—where the net positive suction head is limited. This pump is a multi-stage pumping unit mounted in a barrel from which it takes suction. Base of the pump is at ground level, while length of the barrel below is determined by the npsh requirement. This arrangement permits pumping from a suction vessel set at a lower elevation. Standard construction: Cast iron cases, bronze fitted, chrome steel shaft and shaft sleeve. Standard sizes, 8, 10, 12 and 14 inch barrels. Sizes to 5,000 gpm and for corrosive liquids and/or temperatures to 750° F., on special order. Write for Bulletin No. 49-6600.

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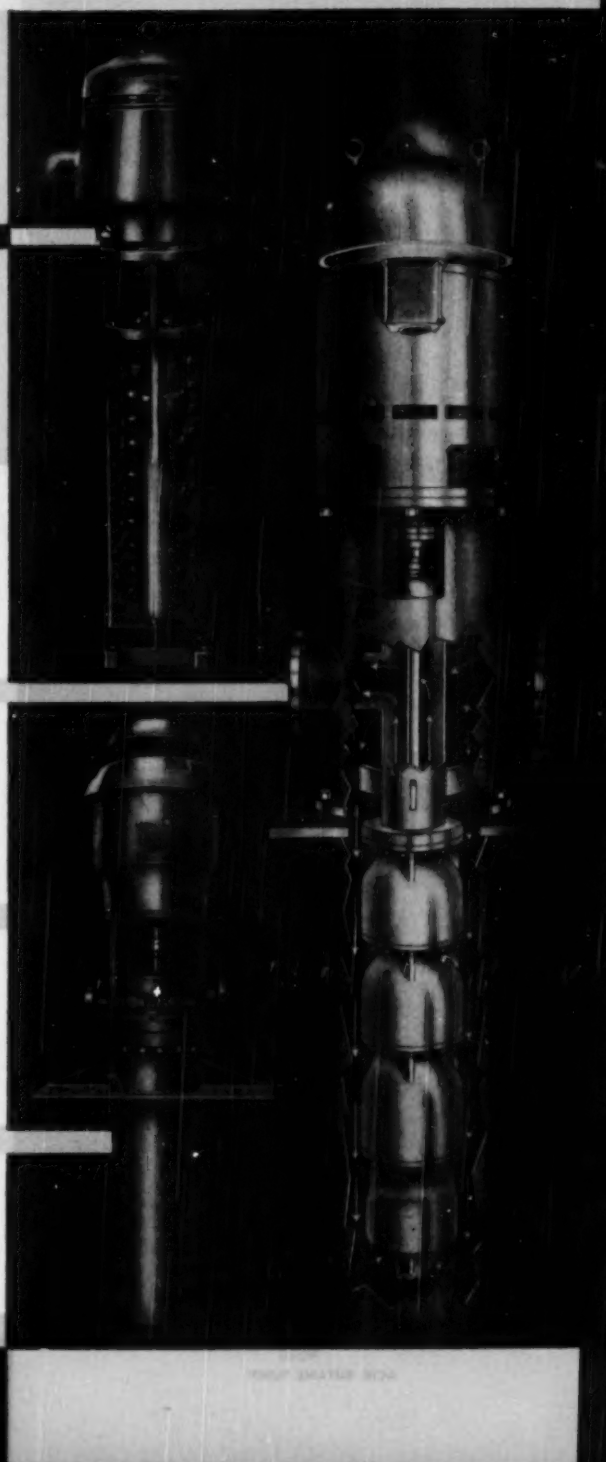

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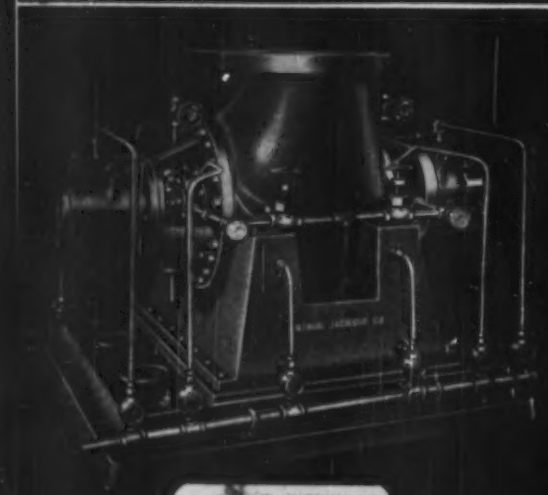

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DOUBLE SUCTION HOT OIL PUMP
(SINGLE STAGE)

Capacity Range: 1000-7000 gpm.
Head Range: 100-700 feet.

Developed for capacities beyond the range of Single Suction Process Pumps. Design is based on proven principles of construction essential for superior service in handling high temperature liquids on continuous operation. Three pump sizes are available—6 x 8 x 10—6 x 10 x 14 and 12 x 16 x 20. Low entrance velocities and axial balance are obtained by use of a double suction impeller. Rotating element can be removed as a unit without disturbing the piping or driver. Pump can be constructed of a wide selection of materials to suit specific conditions.

S. M. PROCESS PUMP

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Capacity Range: 10-1400 gpm.
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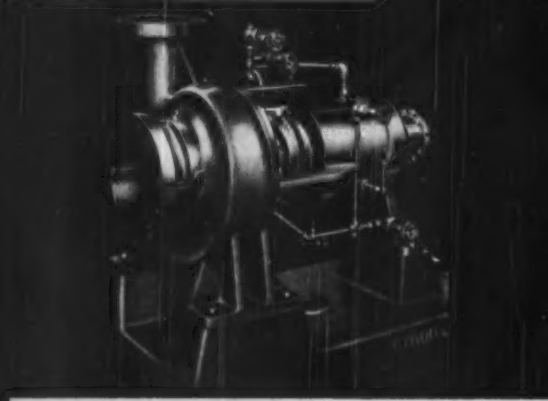
A horizontal, single stage, single suction, split case centrifugal pump for use where temperatures and pressures are high, suction liquid levels low, where hot and cold liquids near their boiling points must be handled, and where liquids impose severe conditions on stuffing boxes. An ideal pump for handling slurry. Alignment is maintained at any temperature. Bearing bracket, shaft and impeller assembly removable without disturbing piping, case, or driver. For temperatures to 850° F. Standard materials: Cases and impellers of cast iron, Meehanite, Ni-resist carbon or chrome alloy steel, or other alloy best suited to particular service. Write for Bulletin No. 49-2400.



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BJ Deepwell models answer practically every standard and special primary water supply need. Deepwell models are offered for well diameters from 6 to 24 inches and the new smaller "Bee-Jay" model is designed for 5 and 6 inch wells. Three distinct types of bowl assemblies and more than 100 individual impeller designs make possible the selection of a BJ Deepwell Pump to meet any conceivable requirement. As originators of the deepwell turbine pump, Byron Jackson Co. has continued to provide the best in deepwell pumping performance and dependability. Write for Bulletin No. 49-5000.

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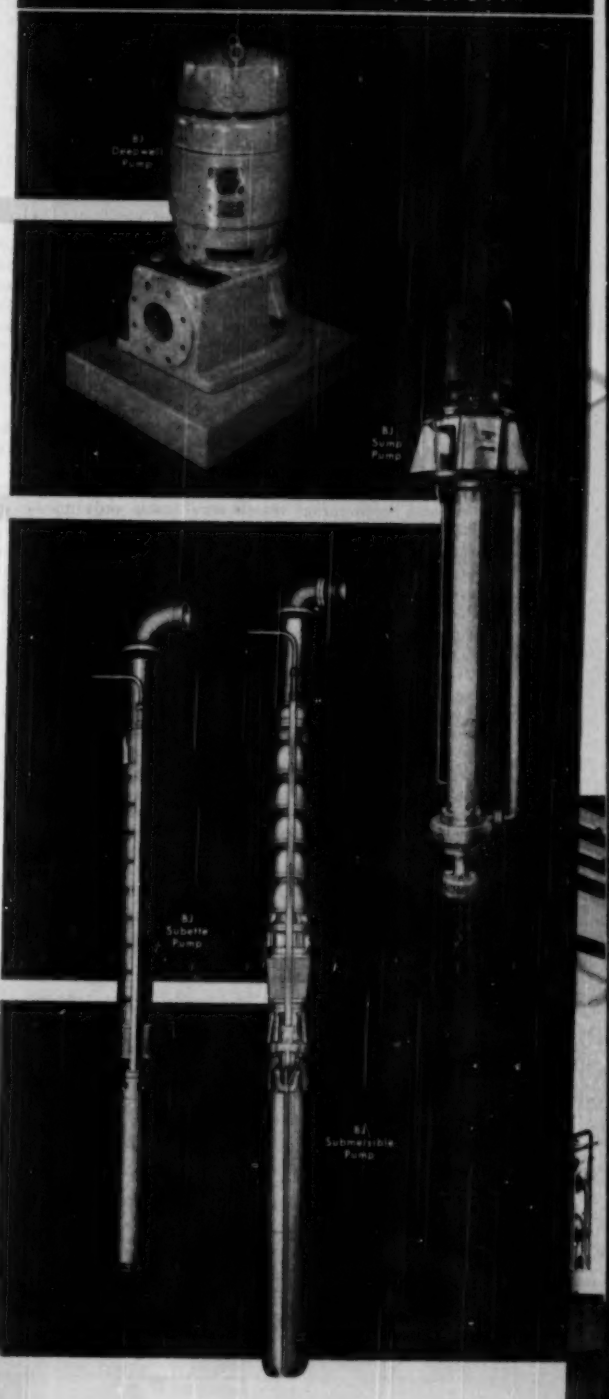


Fluid Catalytic Cracking Process Improved Through Better Design of Components

R. T. ARMSTRONG
Petroleum Refinery Division
Foster Wheeler Corporation, New York

THE FLUID catalytic cracking process has found wide acceptance in our refineries. Commercial units now remain on stream at high thruput rates for long periods, often in excess of a year. Besides a sound basic process, these achievements reflect a great amount of careful attention to individual details of equipment design and choice.

THE first commercial Fluid catalytic cracking unit was designed before World War II and was intended for motor gasoline manufacture. This plant was located at the Baton Rouge, La., refinery of Esso Standard Oil Company. It was promptly shifted to war products operation, using synthetic catalyst, to make butylenes for synthetic rubber and alkylation in addition to light paraffinic and heavy aromatic aviation gasoline.

This first plant and other early units were of "upflow" design, the catalyst reaction and regeneration vessels serving merely as time tanks with catalyst separation being accomplished in supplemental equipment. The upflow units were closely followed by a "downflow" design which has become standard practice for fluid cracking plants. Many such units were built during the war years and since. The downflow process scheme continues in use now without fundamental change.

Several companies hold the patent rights under which the process is licensed. These companies, various other refiners who utilize the process, and the engineer-contractor companies that design and build these units, have all contributed ideas to the fluid cracking art. The process, while not basically changed, has been greatly improved in many details of design, operation, and maintenance. For one thing, the Fluid catalytic cracking process brought into extensive refinery usage several items of equipment that had been of comparatively little interest to refiners. It was only to be expected that some time would be required to work out various problems introduced by a radically new process and by this new equipment. The process, while not complex, does involve many variables. Refinements in plant arrangement, equipment, and operating conditions have produced worthwhile gains in throughputs and length of runs. Notes on the current thinking of one engineering group on several of the problems encountered in the design and operation of these units may be of interest.

Figure 1 shows the basic downflow design for Fluid catalytic cracking units. The catalyst is a finely divided powder. The process is truly continuous, with the cracking reactions occurring in a reactor into which fresh feed mixed with active catalyst is continuously charged and from which cracked vapors and spent catalyst are continuously and separately withdrawn. The cracking reactions leave a carbonaceous deposit on the catalyst surface. This deposit is burned away from the spent catalyst in a regeneration vessel by combustion with air. Fresh hot regenerated catalyst is mixed with fresh oil feed. The catalyst serves as a heat source to completely vaporize the oil and to raise it to cracking temperature levels.

In these units the essential operations of oil reaction, catalyst transfer, and catalyst regeneration are hinged

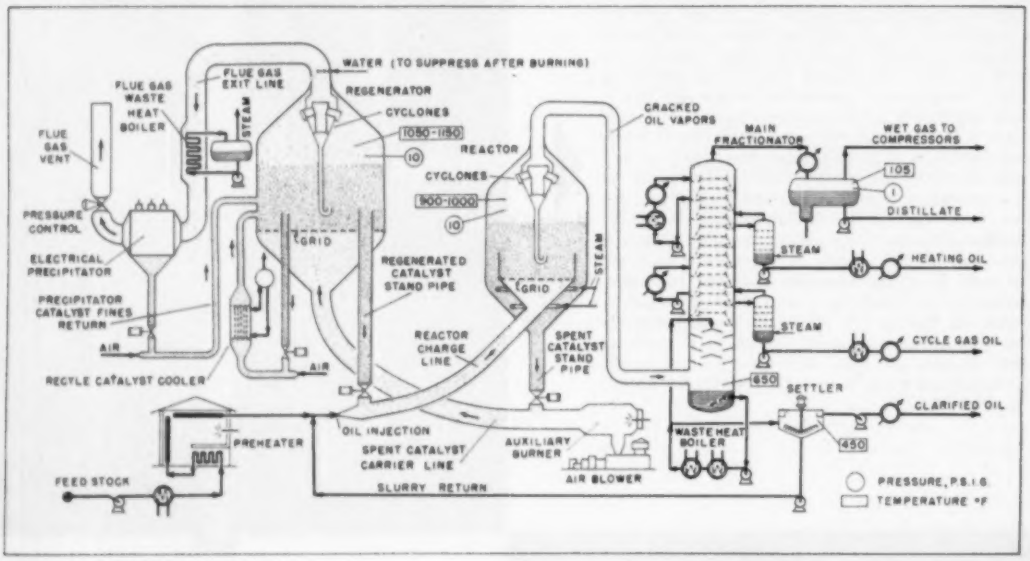


Figure 1. Typical fluid catalytic cracking process flow diagram. Reaction, catalyst regeneration, and primary fractionation of cracked products are accomplished here. Gasoline stabilization and the recovery of hydrocarbon gases are provided in a secondary fractionation unit.

upon the behavior of powdered materials maintained in mixtures with vapors and gases. Such mixtures become "fluidized." Their density can be controlled, within limits, by varying the quantity of gas added and by changing the rate at which the fluid mixture moves in vessels or piping.

Completely vaporized oil feed in mixture with hot regenerated catalyst enters the reactor through a grid or other distribution device beneath the catalyst bed maintained in this vessel. The oil vapors bubble up through the catalyst bed. The bed in the presence of these rising vapors becomes fluidized. The mixture resembles a boiling liquid and a high state of turbulence exists. There is a fairly definite "liquid level." Sufficient reactor diameter is provided so that exit vapors leave the bed at velocities of the order of 1 or 2 feet per second, low enough to avoid excessive entrainment of smaller catalyst particles. Cyclone separators return most of the entrained catalyst to the bed. Bed densities range 20 to 40 pounds per cubic foot, and are termed "dense phase." The regenerator catalyst bed is maintained in similar state. Here air for catalyst deposit combustion serves as the fluidization medium. The circulation of catalyst between reactor and regenerator is accomplished without moving mechanical parts within catalyst vessels or piping.

Catalyst is withdrawn from the base of the reactor into a stripping zone where it is aerated with steam to maintain a fluidized bed, to vaporize adherent oil, and to displace hydrocarbon vapors from catalyst voids. Stripped catalyst flows down into a standpipe. Steam and stripped vapors flow up through the catalyst bed into the reactor. Catalyst in the standpipe is slightly aerated, usually with steam, to maintain a dense phase fluid state. The mixture thus behaves as a liquid, so that the standpipe serves to provide an outlet pressure at its lower end which is considerably higher than the pressure above the catalyst bed in the reactor. Standpipe density will be 20 to 35 pounds per cubic foot. This pressure differential is needed for the transfer of catalyst. Standpipe velocities range from 2 to 7 feet per second. Catalyst flows from the standpipe base through a throttle or "slide valve" to mix with a fast moving stream of air which enters the regenerator to provide combustion oxygen for burning the carbon deposit from spent catalyst. This air serves to transfer catalyst to the regenerator and to fluidize the catalyst bed there.

Ratios of air to catalyst volumes in this carrier line are high so the mixture is low in density. Velocities range 15 to 40 feet per second, exceeding the settling rates of the heavier catalyst particles, and the mixture readily flows up to enter the regenerator through a suitable distribution device beneath the catalyst bed there.

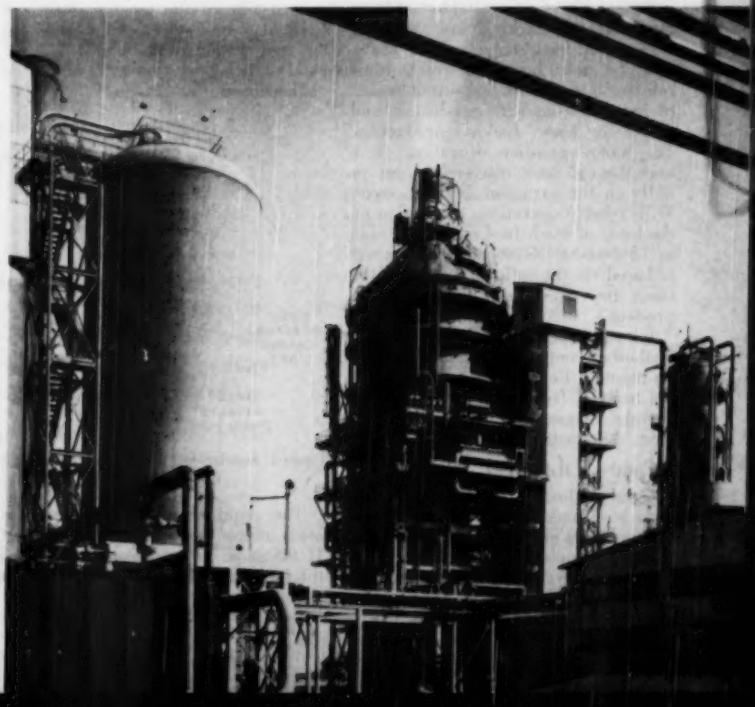
The regenerator is operated at a pressure below that existing at the base of the spent catalyst standpipe. The low density of the catalyst-air mixture in the spent catalyst carrier line allows for a considerable elevation of regenerator above the standpipe base without an unduly large "fluid head." The regenerator pressure plus the fluid head of the dense phase catalyst bed in the regenerator plus the pressure drop across the entrance distribution grid plus the fluid head in the spent catalyst carrier line plus the friction loss in this line plus the pressure drop across the throttled slide valve must be equal to the pressure existing at the base of the spent catalyst standpipe when the unit runs smoothly in a state of operating equilibrium. Variations in pressure differentials occasioned by changes in rate of catalyst flow or other factors are compensated by adjusting the slide valve to take greater or lesser pressure drops. The low density condition existing in the carrier line is termed "dilute phase" fluidization.

Hot carbon-free catalyst is withdrawn from the regenerator into a "fresh catalyst standpipe." It is slightly aerated, with steam or inert gas. The fluid head at the standpipe base provides a pressure above that existing in the reactor, thus allowing the circulation of catalyst back to that vessel. Carrier medium for the fresh catalyst is oil feed vapor. The oil may be preheated in exchangers or in a furnace or it may be mixed in a comparatively cold state with the catalyst. By circulating a large volume of catalyst sufficient heat can be made available to heat a cold feed. The use of a furnace provides desirable operating flexibility and permits lower catalyst circulation. After contact with the hot catalyst the oil is in substantially vaporized state, whatever its condition before the contact. This vapor occupies a large volume and serves as carrier medium for transferring the catalyst up into the reactor.

It should be noted that the combustion air volume required for catalyst burning is greatly in excess of the maximum amount likely to be needed for catalyst transfer purposes at maximum catalyst circulation rates. Thus the circulation of catalyst is an unlikely "bottleneck" in these units.

Heat Balance

As with any process, the total heat input to a fluid catalytic cracking unit of necessity must equal the total heat leaving the system. Because the rate of catalyst circulation can be readily varied over a wide range, however, the designer has a considerable choice of values for obtaining this balance. If heat is added to the system through a



feed preheater furnace, less hot catalyst will be circulated for a given reaction temperature. However, heat not removed from the regenerator for charge oil heating must leave by some other route. A higher regenerator operating temperature will allow this excess heat to leave with the flue gas. To avoid excessive temperatures, and resultant injury to the catalyst, heat exchangers are sometimes provided to control the regenerator temperature.

Many recent catalytic cracking units have been of the "heat balance" type—no catalyst coolers for removing heat from the regenerator or fired heater for the feed are used. In earlier units this design employed weight ratios of catalyst circulation to oil feed of the order of 20 or 25 to one. In more recent heat balance units the catalyst to oil ratios have been kept down in the range of 10 or 13 to one by the use of higher regenerator temperatures (approximately 1125° F. instead of the 1075° F. which formerly was considered maximum). A principal limitation of regenerator temperature is "after-burning"—the burning of carbon from catalyst particles leaving the regenerator with the flue gas stream. Better control of after-burning by means of spray water quench systems have made higher regenerator temperatures possible.

Recycle Operation

For a given size catalytic cracking unit the most attractive operation is usually achieved if the total feed is virgin stock. However, if there is not sufficient crude oil available to fill up the catalytic cracking unit capacity with fresh feed, recycling of heavy catalytic gasoil may be desirable. Most refiners find this an important means of increasing gasoline production and decreasing heavy fuel oil production. For motor gasoline operation on a once-through basis conversions are usually in the range of 50-55 percent. With recycle operation, conversion on the basis of fresh feed may be as high as 75 percent. (Conversion percentage is based on the ratio of gasoil in the fresh feed to gasoil in the reactor product.)

Recycle operation also provides a method of controlling the heat balance on the unit. For a given conversion on the basis of fresh feed, increasing the recycle increases the removal of heat from the reactor system.

Catalyst Recovery Equipment

Catalyst losses from recovery systems with and without electrical precipitators are about the same. Although a precipitator may collect large quantities of catalyst fines (10 to 15 pounds per barrel of feed), this catalyst is returned to the system and recycled.

A number of fluid catalytic cracking units have been built without precipitators, but with two stages of cyclone separators in the regenerator. Three stages of cyclones show only slightly greater catalyst recovery than two stages. In general the third stage cannot be justified on the basis of better catalyst retention. However, the third stage may possibly be justified on the basis that it will permit a longer run if the first stage fails through erosion.

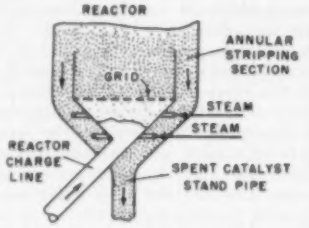


Figure 2. Annular stripping section for spent catalyst.

Catalyst Stripping

Several arrangements have been used to accomplish stripping of spent catalyst leaving the reaction zone. An early design, Figure 2, provided for catalyst stripping in an annular space between reactor inlet grid and reactor shell. Another design, Figure 3, varies this by using an annular inlet grid and a central circular stripping section. Still another arrangement, Figure 4, utilizes a segmental stripping section located at one side of the reactor. Strippers have also been designed as separate external sections, Figure 5, with spent catalyst being withdrawn from a side connection on the reactor.

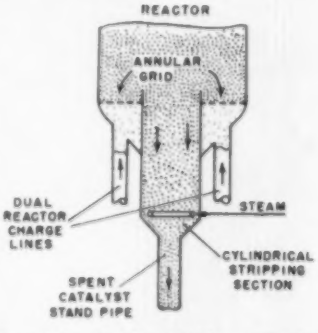


Figure 3. Annular inlet grid with center catalyst stripping section.

The required minimum conversion often affects the design of the stripper. If the required minimum is low and the feed stock is easily cracked so that a low reactor hold-up is required, the distance between the reactor grid and the stripper entrance must be short. This may eliminate the segmental type stripper, Figure 4, from consideration.

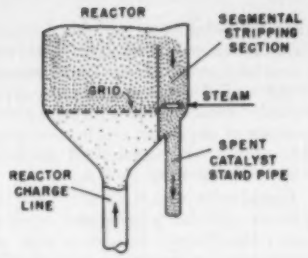


Figure 4. Segmental stripping section inside reactor.

A stripper of the type shown in Figure 2 requires that a rather large dummy section be included below the reactor grid, if short catalyst reaction times are to be provided. This is indicated in Figure 6.

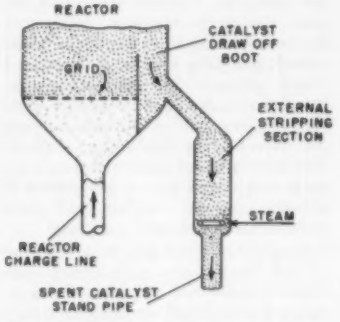


Figure 5. External stripping vessel for spent catalyst.

Good distribution of catalyst entering the stripper is of considerable importance in obtaining satisfactory stripping. The design shown in Figure 2 probably excels in this respect, even though it does have other limitations.

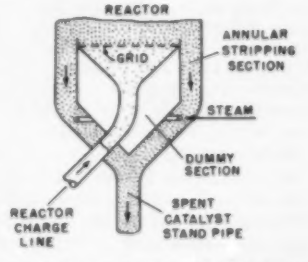


Figure 6. Dummy section used with annular stripping zone to provide short reaction times.

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Also important in stripper performance is an absence of localized backward flow of catalyst from stripper into reaction zone. Various provisions may be made to achieve these objectives, which are closely related. In some designs restriction orifices have been used at the stripper entrance.

Good steam distribution is essential in a catalyst stripper if thorough contacting of catalyst is to occur. Baffles are now extensively used for this purpose. In designs intermediate between the one shown in Figure 2 and current practice, a high ratio of stripper length to diameter was regarded as important. In some of these older strippers good distribution was not obtained and high length to diameter ratios, of the order of 4 to 1, were used. With better distribution and baffling these ratios are less important.

Catalyst Carry-Over from Reactor

In a fluid catalytic cracking unit without an electrical precipitator in the regenerator flue gas system the concentration of fines in the circulated catalyst is much lower than otherwise. As a result the reactor cyclones recover a higher percentage of the catalyst that enters them with the reactor effluent oil vapors. The catalyst carry-over from the reactor is sharply reduced. This is important, since this carry-over accumulates in the heavy oil bottoms of the main fractionator. Past practice often involved settling this slurry in special equipment to produce a decanted oil free of catalyst contamination and a more concentrated slurry which was returned to the reaction system. By the use of two stages of cyclones in the reactor it is possible in units without precipitators to eliminate all slurry settling operations. The entire fractionator bottoms stream, comparatively small with this arrangement, can be returned to the reactor, or the bottoms can be utilized in fuel oil blends. Some refiners will not permit this heavy (above about 750° F. boiling point) catalytic cracked gasoil to be sold, since it contains certain multicyclic aromatic hydrocarbons considered to be a health hazard. These hydrocarbons may cause cancer by contact with the skin.

Catalyst Handling

Early fluid units used bag filters for handling catalyst. These have been eliminated in many recent units. The poor life of the bags, their temperature limitations, and difficulties with associated mechanical equipment have all led to the adoption of other methods of catalyst handling. The use of cyclones and steam operated air ejectors are now preferred. Catalysts may be drawn into the cyclone directly with catalyst dumped into the storage hopper through a pressure lock, or the catalyst may be drawn into a storage hopper held under a vacuum with air passing through a cyclone to a vacuum jet. Either system may be used for "vacuum cleaning" of catalyst from the unit, fresh catalyst unloading, and spills.

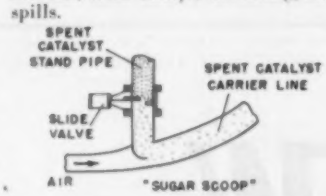


Figure 7. Junction of spent catalyst standpipe with spent catalyst carrier line.

Stacked Units

Several recent units of medium or small size have been designed with the reactor supported above, and sometimes upon, the regenerator vessel. In order to maintain pressure balance the regenerator pressure of these units is increased. This results in a smaller regenerator vessel and requires much less structural steel. Offsetting this saving to some extent is the increased steam consumption of the air blower. In a small unit the reduction in first cost of the stacked unit is easily justified.

Regenerator Lining

The regenerators of the early units were lined with refractory tile. In some more recent vessels monolithic linings of several types have been used with excellent results. One such lining procedure includes stud-welded connections to the inside of the regenerator vessel, an insulating castable cement to a depth of 3 inches or so which is applied with cement guns, a ¾-inch layer of expanded metal mesh, and finally a refractory castable cement that is applied by gun over and through the metal mesh. Expansion joints are left in the mesh and refractory every two or three feet.

A similar method is used to provide wear resistance in catalyst lines. Here the insulating cement may be omitted and the metal mesh welded directly to the inside of the line. Excellent resistance to erosion has been achieved.

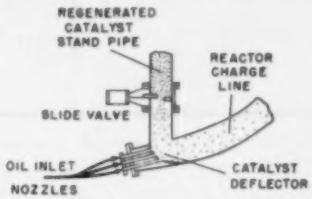


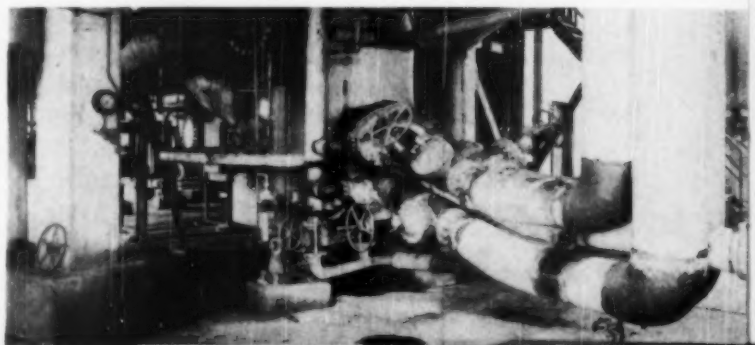
Figure 8. Junction of fresh catalyst standpipe with oil inlet line to reactor.

Spent Catalyst Injection and Oil Injection

The junction of the spent catalyst standpipe with the spent catalyst riser carrying catalyst and air to the regenerator, and the junction of the regenerated catalyst standpipe with the reactor riser carrying oil and catalyst to the reactor have been trouble spots in many Fluid cracking units because of excessive eorsion. With the "stacked unit" the first of these junctions has been eliminated. Spent catalyst flows to the regenerator by gravity. However, the problem has been solved with a fair degree of success for units with conventional arrangement of reactor and regenerator. The "sugar scoop" design shown in Figure 7 is used for the spent catalyst injector, while the one shown in Figure 8 is used at the oil injection point. They have not only reduced erosion but have also provided a noticeable reduction in the amplitude of pressure fluctuations throughout the units.

Vapor Recovery

In recent designs for vapor recovery units of large catalytic cracking units, centrifugal compressors appear very attractive. If the capacity exceeds 5000 barrels per day and the required absorber pressure does not exceed 100 psig., economic units can be worked out. It is practical to obtain 80 percent propylene recovery without refrigeration in such an absorber.



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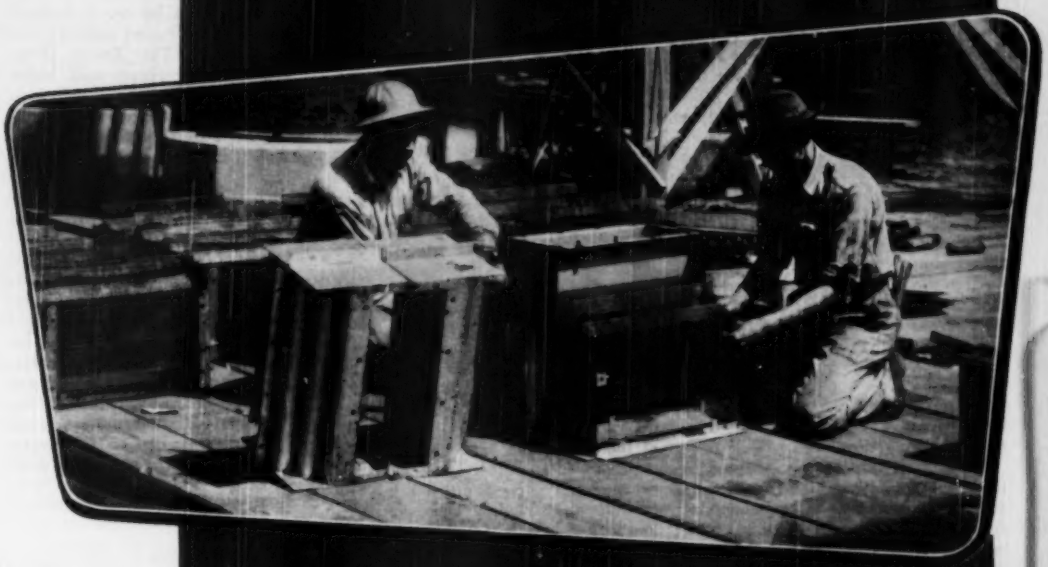

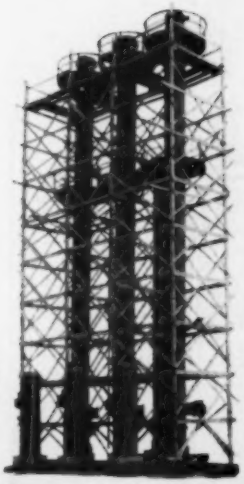

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Furfural Process Adapted to Operate On Wide Variety of Charge Stocks

Texaco Development Corporation

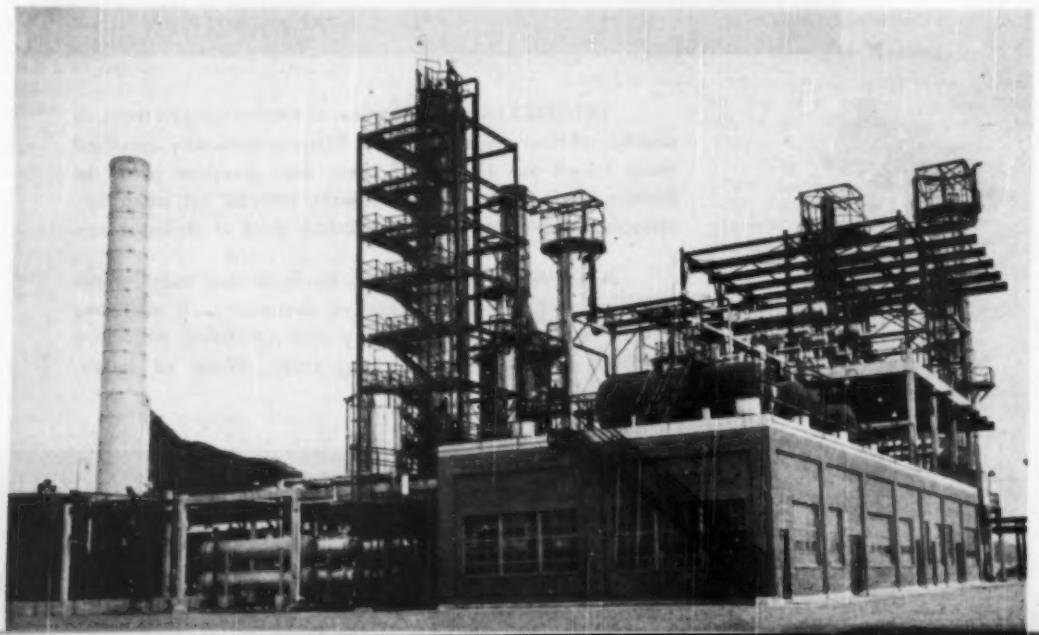
FURFURAL has been used extensively for many years as an extractive solvent for refining lubricating oil stocks and to a lesser extent diesel fuel oils and gas oils. Its use in the latter field is being rapidly extended by The Texas Company. Pilot plant and large scale experimental studies in the use of furfural for the extraction of gas oils, catalytically cracked cycle oils and other middle distillates extending over a period of years, together with an accumulation of data which Texaco Development Corporation has collected in its experience refining lubricating oils, have culminated in the design and erection of the unit at The Texas Company's Westville, New Jersey, refinery to furfural refine such gas oils. This presentation was prepared through cooperation with Texaco Development Corporation.

THE Westville, N. J., furfural plant, originally designed to charge 8000 barrels per day of low boiling distillates has been in commercial production since December, 1949 processing a wide variety of stocks. Skill acquired in the operation of this unit and the ability to operate at a lower than expected ratio of furfural to oil have enabled the company to increase the charge rate to as much as 14,000 barrels per day when charging catalytically cracked gas oils.

Furfural is particularly adapted to the refining of diesel oils, furnace oils and the like because of its selectivity for aromatics, sulfur and nitrogen compounds as well as the ease with which furfural can be recovered from the product streams after water has been added to the oil-solvent mixtures. The flow diagram, Figure 1, illustrates the essential equipment installed at The Texas Company's Eagle Point works.

Untreated oil is introduced into a counter-current extractor at a predetermined temperature. A temperature gradient is maintained between the top and the bottom of the tower by control of the temperature of the oil and furfural charged. Concentration of undesirable oil constituents in the furfural phase increases toward the bottom of the tower from which the extract solution is withdrawn continuously while the refined oil of predetermined quality flows from the top of the tower with a small percentage of dissolved furfural. The refined gas or fuel oils show improved ignition quality and burning characteristics, and a decided reduction in nitrogen, sulfur and metal contaminants.

The raffinate solution flows from the extraction tower through an exchanger to a steam stripper in which suitable temperatures are maintained by a reboiler type of heater. The recovery of furfural from the highly aromatic extract is accomplished in much the same manner. A unique design has been developed for the separation and ultimate discard of all water entering the extraction or solvent recovery systems. Low-boiling petroleum fractions accumulating in the



General View of Furfural Extraction Unit for Middle Distillates Showing the Pump and Control House in the Foreground.

View of Panel Board in Control Room of Furfural Extraction Unit for Middle Distillates.

decanters may be either returned to the system or water washed for the recovery of the small amount of furfural associated with them.

Ignition Quality Improvement

Good ignition quality as well as smokeless combustion and low engine deposits are essential for high speed Diesel engines. Tables I and II reflect the cetane improvement that is typical when refining both virgin stocks and catalytically cracked gas oils. The extent of this improvement, of course, is dependent upon the degree of extraction. Commercial operation has fully demonstrated that the desired degree of refining can be accomplished at a relatively low expense. Utility requirements per barrel of distillate recently experienced are shown in Table A.

TABLE A

Fuel, Barrels per Barrel of Charge Oil	0.0188
Steam at 250 psig., Pounds per Barrel of Charge Oil	43
Steam Recovered as Exhaust at 15 psig., Pounds per Barrel of Charge Oil	19
Net Pounds of Steam Consumed, Pounds per Barrel of Charge Oil	24
Cooling Water Circulated, Gallons per Barrel of Charge Oil	250

Improvement in Burning Quality

Burning tests using a pot-type burner have demonstrated that smokeless combustion is obtained burning furfural refined catalytically cracked fuels with only a small percentage of excess air. In this test carbon deposits amounted to 0.004 percent of the oil burned compared with deposits of 0.056 percent when burning unrefined cracked

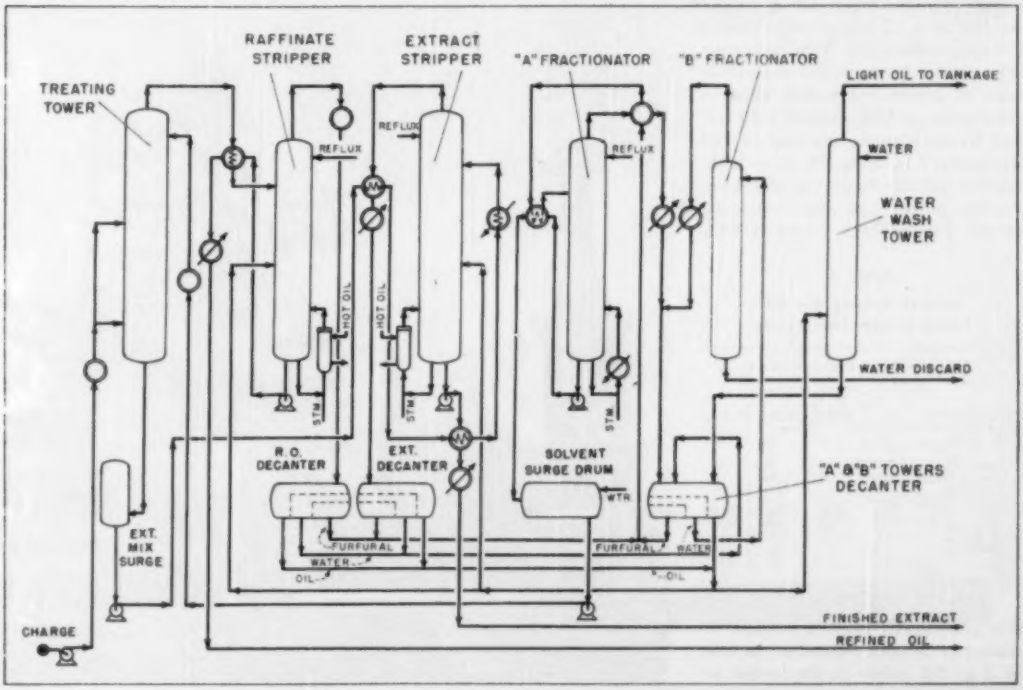


Figure 1. Flow diagram showing essential equipment of Furfural extraction unit installed at The Texas Company's Eagle Pass works.

TABLE 1

Furfural Refining Gas Oils
Cetane Number Improvement

	VIRGIN STOCKS						CRACKED STOCKS					
	Venezuela		California		West Texas		Arabian		Venezuela		California	
CRUDE SOURCE	Charge	Raffinate	Charge	Raffinate	Charge	Raffinate	Charge	Raffinate	Charge	Raffinate	Charge	Raffinate
Yield, Vol. Percent	100	66.6	100	95.0	100	82.0	100	60.0	100	60.5	100	65.5
Cetane No.	34.4	49.6	46.2	50.6	53.2	62.9	19.0	61.0	33.6	53.0	37.7	55.1
Gravity, °API	24.2	30.8	28.9	30.6	33.9	37.8	20.2	40.4	24.5	33.6	29.7	38.8
Color, NPA	7	3-6	.....	.....	.....	.....	2½	1½	7	1—	.....	.....
Sulfur, Wt. Percent	0.80	0.37	0.98	0.72	1.12	0.49	1.705	0.451	0.58	0.09	0.50	0.06
Distillation ASTM												
IBP, °F.	430	462	416	412	374	390	454	454	418	452	436	416
10 Percent	478	502	466	470	492	492	488	490	457	477	470	458
50 Percent	572	584	584	593	560	560	521	530	543	561	510	506
90 Percent	695	710	746	754	598	596	585	590	652	666	580	580
E.P.	734	752	.....	.....	618	620	642	634	716	718	646	638

fuel oil with a large amount of excess air which was necessary for smokeless combustion.

Tests on virgin and catalytically cracked stocks show sulfur reductions ranging from 25 to 90 percent of the sulfur contained in the original charge stock, depending upon the character of the charge and the degree of extraction.

Extraction with furfural has been found to bring about a substantial removal of nitrogen compounds and metal contaminants. As an example, data for refining of California virgin gas oil are shown in Table 1. The removal of only 5 percent of extract resulted in a 67 percent reduction of nitrogen bodies and a 70 to 80 percent reduction in the metal contaminants—iron, vanadium and nickel. Thus, in subsequent cracking operations the carbon lay-down on the cracking catalyst was reduced by about 75 percent, the catalyst activity improved and a reduction in the hydrogen factor obtained. The naphtha produced from

TABLE 2

Furfural Refining Gas Oils
Cetane Number Improvement

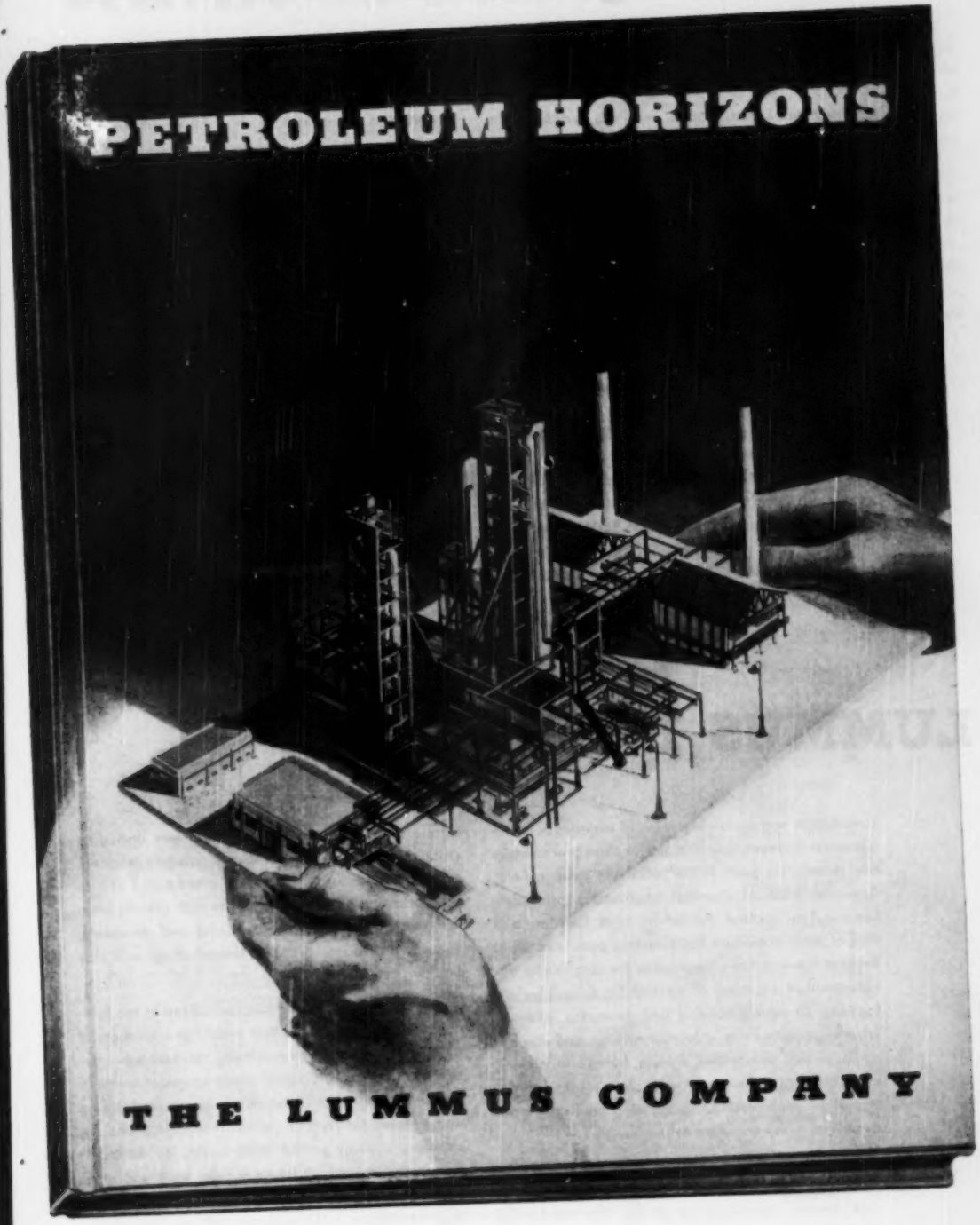
	CRACKED STOCK			
	California			
CRUDE SOURCE	Charge	Raffinate	Raffinate	Raffinate
Yield, Vol. Percent	100.0	83.6	72.7	63.6
Cetane No.	38.4	45.3	52.1	57.7
Gravity °API	28.6	32.0	35.4	38.1
Color NPA	3½	2	1½	1½
Distillation ASTM				
IBP °F.	461	477	478	479
10 Percent	495	499	499	496
50 Percent	530	530	531	532
90 Percent	580	581	582	585
EP	622	623	616	623

this catalytically cracked furfural extracted cycle stock showed an increase of 2 to 2½ points in the leaded octanes of finished gasoline and no decrease in yield as compared with virgin stock.

Commercial operation of the process has proven the economy of producing diesel fuel oils and furnace oils of improved quality by furfural extraction and has increased the available supply of catalytic cracking stock.

The process of extraction of gas oils, cycle oils and middle distillates with furfural is a development of The Texas Company and is licensed by Texaco Development Corporation.

General View of Furfural Extraction Unit for Middle Distillates Showing Furfural Extraction Tower in the Foreground.


PETROLEUM HORIZONS
THE LUMMUS COMPANY

LUMMUS Organization & Services

The Lummus Company, having main offices and laboratories in New York, and branch offices in key cities of the United States, London, and Paris, is available to petroleum refiners and chemical manufacturers as a complete and integrated engineering service organization prepared to undertake anything from factual economic analysis of contemplated plant expansion to actual design, construction, and initial operation of unit process plants in these industries.

Extensive laboratory facilities are maintained for fundamental process development, charge stock evaluation, and pilot scale tests on units of varying size for such operations as distillation of all types, thermal and catalytic cracking, continuous coking, propane deasphalting, solvent refining and dewaxing, wax deoiling, and other related processes. By means of such pilot plant tests Lummus can fulfill its obligation to disinterestedly select that process or combination of processes best suited to a client's product requirements from given charging stocks. On the basis of these tests the engineering staff develops the full scale plant process and mechanical design. Material and equipment are purchased, inspected if necessary, and shipment coordinated with the requirements of the field construction department. Much of this equipment, such as all types of shell and tube heat exchange equipment and fabricated piping may be furnished by Lummus manufacturing divisions. As plant construction nears completion Lummus operating personnel conduct preliminary tests of the equipment and, finally, supervise the initial operation and performance tests for customer acceptance.

The interest of the Lummus Company in any particular installation does not end at this juncture, however, for field representatives make periodic visits to the plant keeping a record of its operating performance, maintenance requirements and long term efficiency. Should charging stocks or product requirements radically change, such check-up will enable the prompt preparation of suggested plant alterations to meet the new demands. In the last analysis, only on such long term familiarity with a plant's performance and suggestions and observations by its operating staff can future design be intelligently based.

LUMMUS Background

Lummus has had some sixty years of experience in the design and construction of chemical plant process units and twenty-five years in the petroleum refining field. Since the birth of chemical engineering principles, Lummus has applied distillation, heat transfer, and flow of fluids in modern chemical and petroleum plant designs. Lummus has pioneered in the commercial development of a number of successful processes including lube oil solvent refining and dewaxing, selective cracking, polyforming, catalytic cracking, and wax deoiling, as well as ethylene, styrene, butadiene, phenol, and azeatrophic toluene production units, and has designed and built petroleum processing units of all types as well as many complete refineries.

In the chemical field Lummus has built over 300 units including alcohol, benzol, phenol, ethylene, butadiene, and styrene manufacturing plants. The number of plants for the manufacture of motor gasoline and 100 octane aviation gasoline from petroleum, including crude distillation, thermal cracking, catalytic cracking, polyforming, and polymerization units exceed 170. In the lubricating oil field, Lummus has built over 90 process units employing solvent refining and dewaxing, vacuum distillation, propane deasphalting and clay finishing processes.

The Oil Heater Division has specialized in the intricate design of direct fired heat exchange equipment of all types and has developed many advantageous design features for this highly important plant element. The wide experience of Lummus in heavy engineering and process construction, in the marshalling and supervising of large project labor forces, is reflected in its enviable records of freedom from work stoppages and rapid plant erection schedules. Lummus worldwide operations include plants built all through Europe and the Near East, South America, and the Orient.

CHEMICALS from Petroleum

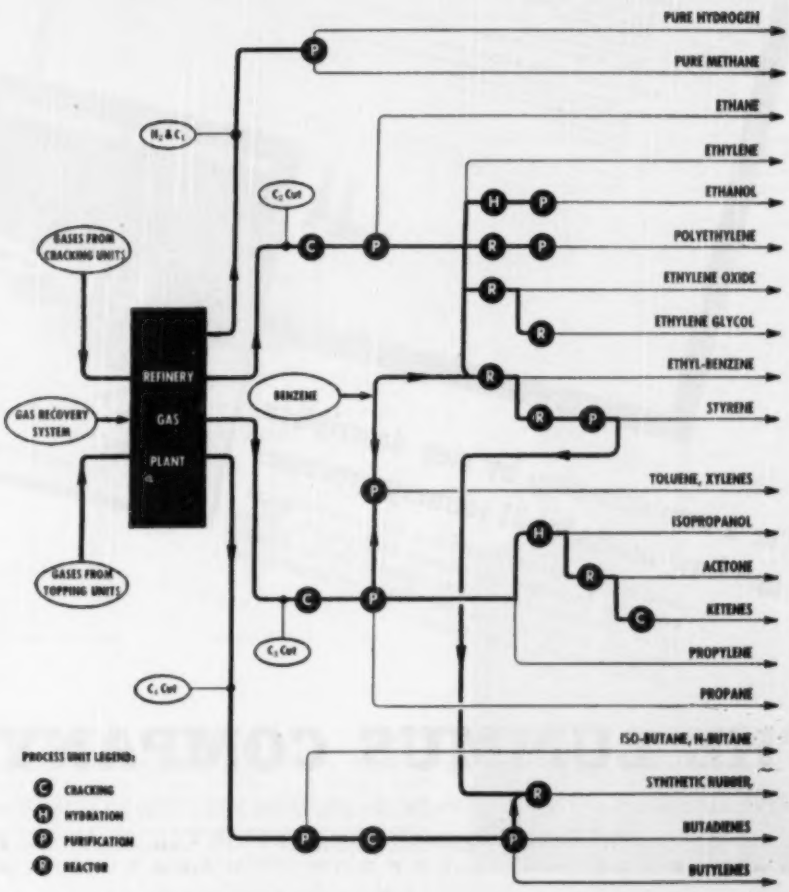
The use of petroleum as a basic raw material for organic synthesis was originally brought about partly by the shortage of coal-derived products, and may be said to date commercially from the production of toluene from petroleum during World War I.

By 1940, research and development had brought the industry to a point which made possible the large-scale World War II production of petroleum chemicals for the synthesis of chemical products. The development of this petroleum chemical industry was accelerated in the early stages of World War II, and has continued unchecked as shown by the ever-growing number of companies engaged in activities of this nature.

The Lummus Company, with its wide range of experience, has contributed to this growth — both in the development, and in the design and construction of some of the first plants for manufacturing ethylene, propylene, styrene, butadiene, ethylene oxide, ethylene glycol, toluol, alcohols, etc.

Because of the growth of this new industry, petroleum is no longer solely a fuel, but has become a prime raw material for such diversified products as organic chemicals, detergents, synthetic rubber, plastics, acrylic resins, vinyl resins, styrene resins, ethyl cellulose resins, etc. A few typical petroleum chemical syntheses are shown in the Schematic Flow Diagram below.

CHEMICALS AND CHEMICAL INTERMEDIATES FROM REFINERY GASES



For a complete step by step description and flow sheets for 31 refinery processes

send for Petroleum Horizons, the new 80-page book on Lummus processes and plants. This book gives you complete details on the background, organization and world-wide services of the Lummus Company.

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Shale Retorting Process Verified by Test Run

Union Oil Company of California, Los Angeles

THE DEVELOPMENT of adequate processes for extracting shale oil from shale will greatly improve our position with respect to fuel reserves. Increasing consumption of crude oil reserves coupled with increasing costs for exploration and production of crude oils promises to make shale oil mining and recovery commercially attractive.

A CONTINUOUS shale retorting process has been developed by Union Oil Company of California, Los Angeles. Figure 1 presents a 50-ton-per-day plant now in operation. A highly successful long period test run has recently been completed, which has completely verified the commercial features of the process. The accompanying photograph was taken during the test run.

Shale, introduced to the kiln at the bottom, passes through a liquid product seal, where it is forced upward by means of a hydraulically operated piston feeder. Air is drawn downward countercurrent to the moving bed of shale and is disengaged from the unit at the slotted cone at the bottom of the retort. The air is first preheated by the hot spent clinker at the top of the kiln, burns off the residual carbon on the clinker in the next portion of the bed to supply the heat for eduction of the oil in the lower section of the bed. The educated oil and the combustion gases are disengaged from the kiln through the slotted cone and pass through a cyclone in which the oil is separated. The spent clinker at the top of the kiln is broken up by a rotating plow and discharged by chute to a disposal bunker.

The unit is self-contained with respect to utilities, all heat required for the eduction of the oil being furnished by combustion of residual carbon on the spent shale, and combustion of stack gases furnishes more than sufficient power required for the rest of the plant. No cooling water is required.

Recovery of oil from the shale consistently averages 100 percent of the standard assay value. The process, being continuous and countercurrent, has a very high thruput per unit volume coupled with low operating and maintenance costs.

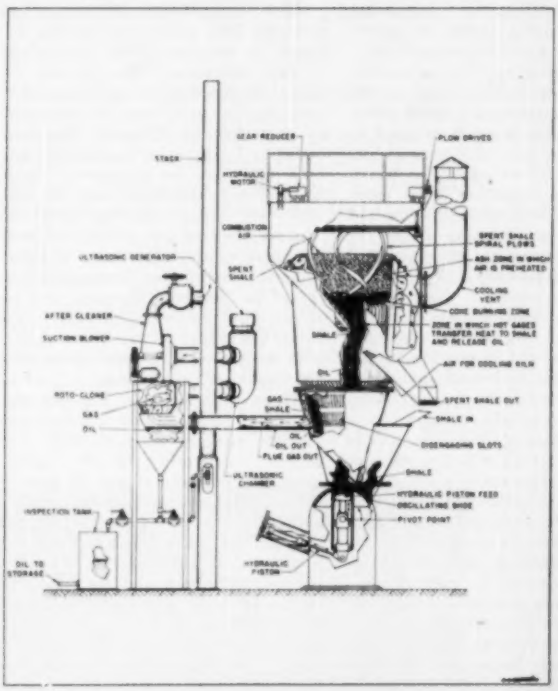
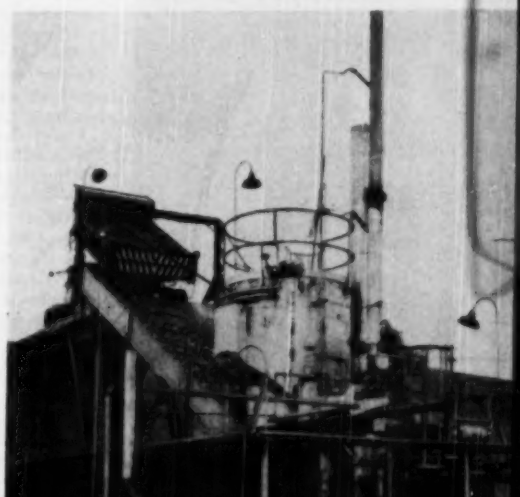


Figure 1. Shale retorting apparatus. Shale is introduced at the bottom through a hopper and is fed upward into the retort by a hydraulic piston that oscillates, making first a downward "suction" stroke under the feed hopper and then an upward "discharge" stroke under the retort body. The shale moves upward through the retort, finally leaving via a top overflow chute as spent clinker. Air for combustion enters at the top and is pulled downward through the retort by a suction blower.

Figure 2. Photograph of 50 ton per day plant in operation. Fresh shale is brought to the unit by dump truck and fed to the retort by an inclined trough. Spent shale is discharged to the left of the apparatus for removal by motor scoop.



Product Requirements Determine the Complexity of Gas Recovery Processes

C. C. PRYOR, Associate Editor

THE CONSTRUCTION and operation of several plants for processing natural and refinery gases, employing fractionating-absorbers, provide definite indication of another achievement in the long series of improvements by which the light hydrocarbon recovery processes have been raised to their present status.

The fundamental concept of the fractionating-absorber has been variously applied, and termed, for the removal of methane and ethane from the rich oil stream of absorption-type gas recovery plants. One new trend is the use of the fractionating-absorber for its original purpose—the removal of methane and ethane at the primary point of contact with the lean oil. Although the fractionating-absorber has exhibited certain limitations in regard to feed and operating temperatures and pressures, it appears that in some applications substantial savings in initial plant cost and increased operating efficiencies can be realized.

THE development of markets for natural gasoline and light hydrocarbon products continues to be the major influence controlling natural gasoline process plant technology. In earlier times the principal market sought was the refinery usage of natural gasoline for volatility blending in motor gasolines. Later, a worthwhile market developed for butane and propane in various combinations as "bottle gas" and for bulk sales as industrial and residential fuel. Presently many natural gasoline plants are selling light hydrocarbon products as charge stock for a variety of petrochemicals manufacturing operations.

Also, gasoline plants that have products of suitable boiling range are in many cases marketing a finished motor fuel. Dry residue gases from gasoline plants may be sold to a natural gas pipe line system or may be returned to a producing formation. These gases are too valuable to waste and the old practice of flare burning gases for which we no immediate market existed has largely disappeared.

Under the pressure of these market opportunities, gasoline plant design is moving steadily toward the more complete recovery and separation of the individual light hydrocarbon components of the feed gases. A trend in another direction is also evidenced by a keen interest among plant operators in processes for gasoline octane number improvement. Current quality specifications for premium grade gasoline are not readily met with straightrun stocks, and there is prospect that the conversion processes will be of increasing importance in natural gasoline plant operations for the manufacture of finished motor fuel.

Advances in natural gasoline processing methods have usually been measured in terms of the percentage of liquid recovery for individual hydrocarbon components. Early natural gasoline plants were operated to retain only sufficient butane to set the desired vapor pressures for the natural gasoline product. Substantially all of the lighter gases and much of the butane was discarded to plant fuel or burned in flares. The plants for the most part involved the simple basic plan of absorption, low-pressure steam stripping of rich oil, and stabilization of raw natural gasoline. As markets developed for butane, butane-propane mixtures, and propane, process schemes were devised to accomplish the partial or complete recovery of these light components. Of necessity the new process arrangements were more complex than the earlier ones.

There is a considerable market for propane. New plants are usually designed to recover a high percentage of this component. The recovery of light components by an absorption-type gasoline plant can be increased by several routes, Figure 1. The ratio of lean oil circulation to absorber gas feed rate may be increased. Lower absorption temperatures may be used with heat being removed from the lean oil, the feed gas, or directly from the absorber trays by means of intercoolers. In many cases increased recovery of the desired components can be achieved by raising absorption pressures. Using lean oil of a lower molecular weight will increase absorption for a given oil circulation.

Along with gains in the recovery of desired propane and heavier components, each of these methods also increase absorption of the lighter gases, methane and ethans. In present plant operations methane and ethane gases are used as plant fuel, routed to pipe line sales, or compressed for injection into a producing formation. These unwanted gases must be separated from the propane and heavier products. Also, their presence of appreciable amounts in a rich oil stream greatly complicates the stripping and product separation portions of a gasoline plant. If the absorbed methane and ethane components are allowed to remain in the rich oil charge to the stripping still, their presence in the still overhead vapors will make condensation of the raw product diffi-

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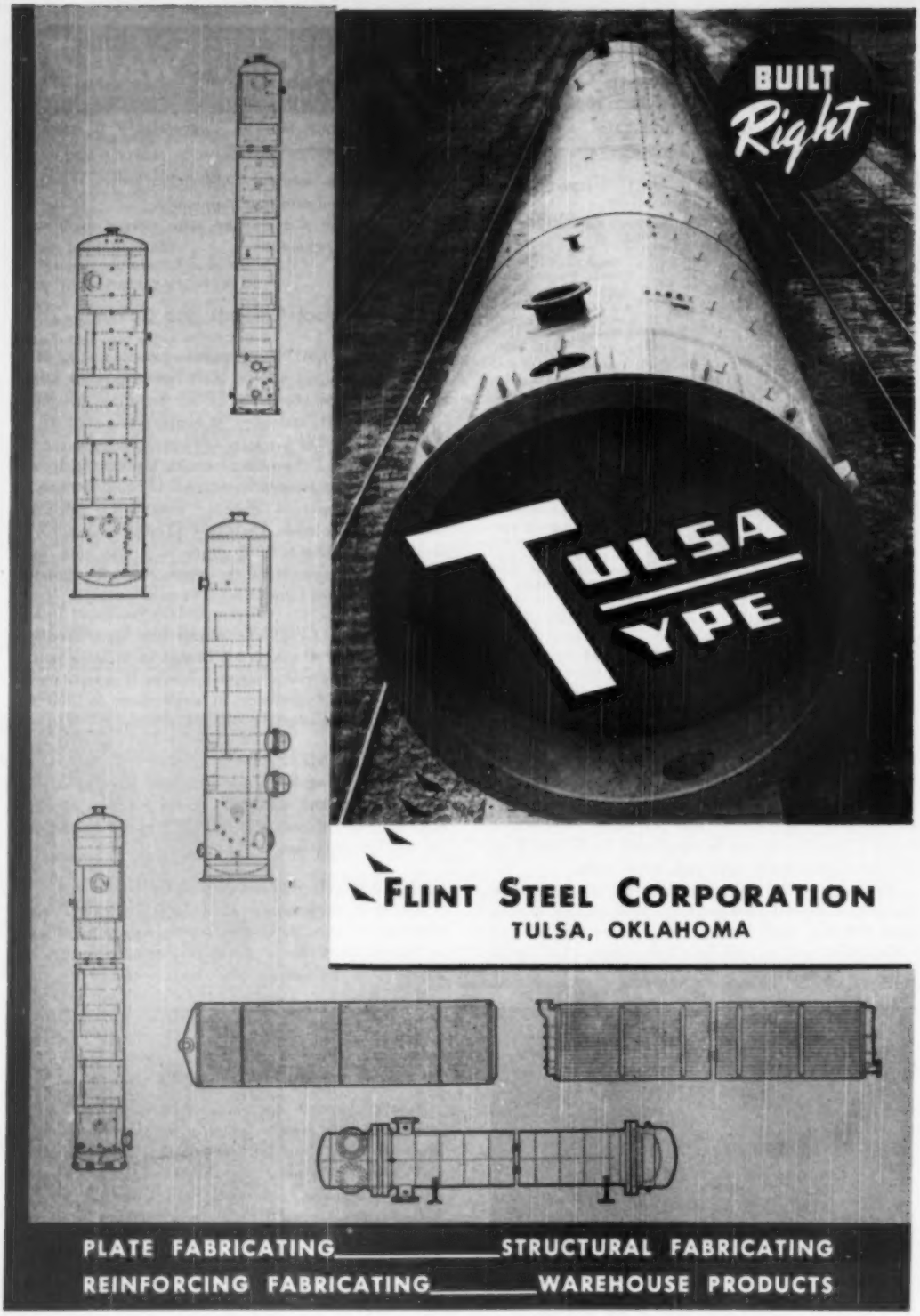
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cult. Increasing still-operating pressure can provide only a partial answer to this condensation problem since the stripping of rich oil is thereby adversely affected. (Increased still pressure requires higher temperatures at the still base, or more stripping steam, or both.)

In cases where most of the raw product can be condensed at the still overhead condenser, the gases present may be compressed and recycled to the main absorber, or may be sent to a low-pressure reabsorber. On occasion, a stream of heavy product liquid may be recycled to the still condenser to assist in the condensation of the product gases.

In cases where there are considerable volumes of still gases that cannot be condensed, they constitute a serious processing problem. They contain heavy components that are too valuable to discard to fuel, but their separation from methane and ethane gases will entail a large investment in processing equipment and increased operating costs. If high percentages of butane or propane are desired as products, it is usually better to provide some means for removing most of the methane and ethane from the rich oil before it is charged to the stripping still.

Several methods are available for removing absorbed methane and ethane from rich oil. A simple flash to a lower pressure will result in venting part of the undesired methane and ethane. The flashed rich oil can then be charged to a still and less difficulty will be encountered in condensing the still overhead vapors. The simple flash, however, results in the loss of desired product vapors. By flashing the rich oil into the base of a low-pressure absorber some of the methane and ethane can be vented from the rich oil system while vapors desired as product can be reabsorbed with a stream of lean oil. If the primary absorber pressure is high, two or more such reabsorbers may be used at successively lower pressures.

Where high recovery of propane is required, a gasoline plant using high-pressure absorption, and reabsorbers becomes rather expensive. In addition to the complications introduced into the absorption and stripping sections of the plant, the presence in the still overhead raw product of considerable amounts of light gases usually necessitates the installation of a fractionator to reject ethane. Because of these complications, designers of high recovery plants have sought other process schemes in an attempt to lower investment and operating costs. Much of their work has been directed toward the more complete elimination of methane and ethane from the rich oil ahead of the still. Fairly effective methods for accomplishing this "fat oil deethanization" have been developed, though there is variation of opinion concerning their economics and applications. The widespread interest evidenced by plant operators and increasing application in new plants suggests that the new schemes are to find extensive use.

Almost 20 years ago, so called "fractionating absorbers" were tried.[1] Two or three trays were added below the gas inlet of an absorber. A small steam coil was placed in the rich oil at the absorber base. The idea, of course, was to strip out absorbed but unwanted light components. No real gain resulted. Reboiling was too small for any substantial removal of methane and ethane.

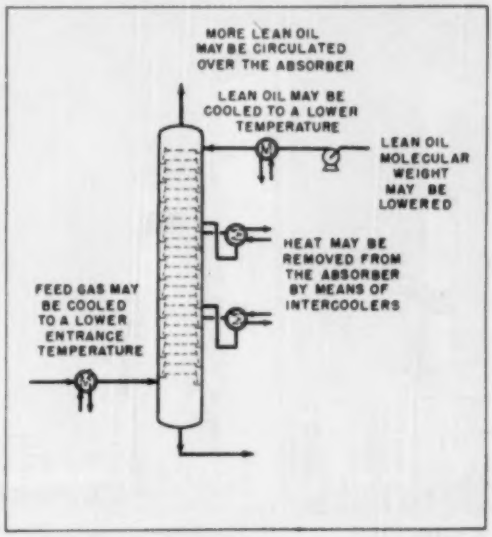

MORE LEAN OIL MAY BE CIRCULATED OVER THE ABSORBER
LEAN OIL MAY BE COOLED TO A LOWER TEMPERATURE
LEAN OIL MOLECULAR WEIGHT MAY BE LOWERED
HEAT MAY BE REMOVED FROM THE ABSORBER BY MEANS OF INTERCOOLERS
FEED GAS MAY BE COOLED TO A LOWER ENTRANCE TEMPERATURE

Figure 1. This sketch illustrates several methods in use for increasing the recovery of propane in the absorbers of gasoline plants.

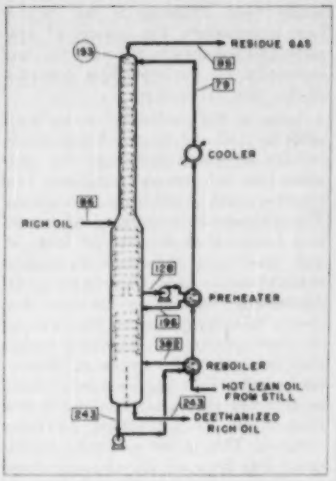


Figure 2. Methane and ethane are removed from the rich oil and propane retained in this column.

Later a certain refinery operation directed toward the recovery of propylene for petrochemicals manufacture employed rich oil fractionation to strip out absorbed methane and much of the ethane without appreciable propylene loss. More recently rich oil fractionation was used in a case where methane and ethane were removed and propane retained.[1] Figure 2 is a diagram of the flow. The main absorber operates like all absorbers. In this commercial design more than 95 percent of the total butanes are absorbed, and more than 60 percent of the propane. The rich oil then goes to the middle of the deethanizer. This deethanizer is a two-section apparatus that combines the functions of a reabsorber with those of a stripping column. It has "reflux" (lean oil rather than condensed overhead product) and a source of reboiler heat. Methane and ethane are effectively stripped from the rich oil so that total condensation of still overhead can be had with usual plant cooling water temperatures and there is no need for a fractionator to remove ethane from the raw product. Certain limits exist for this type of rich oil deethanization. The temperature at the tower base must not exceed the critical temperature of the heavy rich oil components—or, of course, the available temperature level of the source of re-

boiler heat. Pressure is set by the base temperature, the amount of propane and butanes in the rich oil, and indirectly by the operating pressure of the rich oil stripper.

Some of the problems [2] to be dealt with in rich oil deethanizing plants involve the establishment of the optimum lean oil rate and optimum heat recovery, and controlling the column. The optimum heat recovery, of course, is a function of the cost of fuel gas and cooling water, and equipment maintenance and amortization. Of noteworthy interest is the fact that cooler inlet temperatures for lean oil in these plants is sometimes higher than in some other types of absorption plants. This has been interpreted as showing that heat economy is less than might be obtained by other methods. This is not generally so, because less lean oil may be circulated for a given net propane recovery in rich oil deethanization schemes.

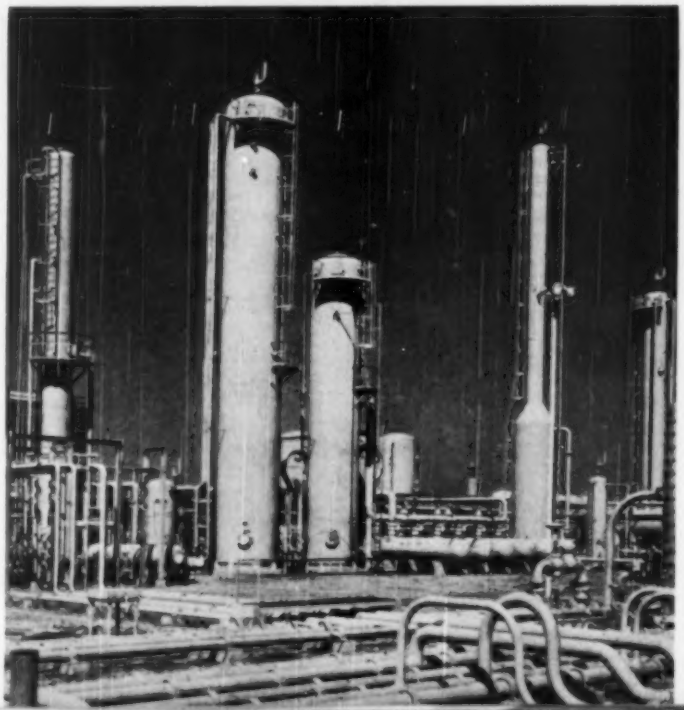
Better heat recovery is possible and sometimes lower heat exchanger surface result from the use of feed preheaters and reboilers for deethanizers.[2] Reduction of the bottom temperature of the rich oil deethanizer improves heat transfer relationships and increases heat recovery. In general, the bottom temperature is a function of the composition of the gas feed, operating conditions of the main absorber and rich oil deethanizer, and the propane recovery. A decrease in bottom temperature can be obtained by injection of propane in the bottom of the tower; or by the use of stripping steam to reduce the partial pressures. These methods, however, do not provide large gains in heat recovery because the lean oil temperature must be high enough for stripping in any case, which determines the heat exchange requirements.

Several advantages over the single reboiler and single preheater schemes are claimed for the rich oil deethanizer column employing preheating on the upper trays of the stripping section and reboiling for the tower bottoms,[3] Figure 2. Heat exchange from hot lean oil to the reboiler and the preheater substantially lowers the duty of the lean oil cooling system, which reduces the cooling equipment required, and eliminates the utilities that would otherwise be required to supply this heat at reboiler and preheater. Another advantage of this system is the higher mean temperature which provides better stripping with fewer trays and less reboiler vapor. This arrangement has been found economical to install and operate over a wide range of feed gas compositions and propane recoveries.[3]

In plants where only partial removal of methane and ethane is required, a preheater system with injection of wet gas at the bottom of the stripping section may be used to advantage. Applications include high pressure absorption on gas transmission lines, where all the gas is returned to the line, except that for fuel. This arrangement can be used to remove as much as 80 percent of the methane and ethane absorbed. The injection of a wet (propane rich) gas stream at the bottom of the stripping section causes propane to be absorbed preferentially in the rich oil. On the basis of the differences in the partial pressures of these components, methane and ethane are released from the liquid phase as equilibrium is approached.[4] These gases with some propane flow into the absorption section. Here the propane and some ethane are absorbed by lean oil. A preheater decreases the horsepower required for compression of uncondensed vapors from the stills.

Completely satisfactory control of rich oil deethanizing columns for propane vapor pressure and maximum propane recovery has not always been achieved. Because the composition of feed to gasoline plant varies over a somewhat wide range, the column cannot be controlled by holding a constant bottom temperature. One method of control [2] is through maintaining the richness of the gas to the top section at the proper level. a specific-gravity instrument measuring the richness of the gas. Another scheme provides indirect control by measurement of the rise in temperature of the lean oil.

Natural gas has larger percentages of methane and ethane than the corresponding gas streams charged to refinery gas recovery and fractionation units. Accordingly, the deethanization of rich oil is usually more difficult in the natural gasoline plants, or at any rate it occupies a more prominent position as a problem that must be solved in setting up a plant process scheme. In natural gasoline plants it has usually been considered best to install fractionating absorbers for rich oil deethanization as a separate process step following the initial contacting of feed gas by lean oil in a primary absorber. In the refineries fractionating absorbers have been used to a considerable extent as the initial process step of absorption units. It is interesting to note, however, that several gasoline plants are now building in which a fractionating-absorber of the preheater-reboiler type will be used instead of a conventional main absorber. This process scheme has been used in refinery gas plants operating at low pressures on rich gases and it appears that where pressure and rich feed are available in natural gas operations, the fractionating absorber will permit a reduction in the initial plant investment.[2]



The flow diagram of one scheme utilizing fractionating-absorbers for natural gasoline processing is shown in Figure 3. This plant [2] is designed for 90-percent recovery of the propane and practically all of the butanes and heavier. Among the features of the design of this plant are the use of two fractionating-absorbers in series, the use of refrigeration, and the use of the recovered natural gasoline as absorption oil. Absorption pressures are about 475 psig. and temperatures 20° F. The first fractionating-absorber, for propane, requires a lean oil rate of 6.3 gallons per 1000 cubic feet of wet gas. Because of the high volatility of the recovered gasoline used as absorption oil, its loss in the overhead gas stream is quite high. Thus, the primary purpose of the second fractionating-absorber is recovery of the volatile fraction of the lean oil. It does not result in an increase in the recovery of propane, except to a minor degree.

As will be noted from the diagram, deethanization of the raw product behind the still is not required and the remaining three columns in the plant are conventional. Refrigeration for the plant is supplied by a conventional compression type refrigeration unit, which uses LPG-propane as refrigerant at two temperature levels, 40° F. and 10° F., for a minimum cost installation.

The fractionating-absorber has been in use in place of the conventional absorber in refinery gas recovery plants for about the same length of time that it has been used for rich oil deethanization in gasoline plants. Additional experience and straightforward methods of design, plus the increasing use in the industry, indicate several advantages in the use of fractionating-absorbers from the standpoint of economics and operation. There are a number of problems, however, that remain to be solved. Among them are the choice of optimum pressures and temperatures and extreme sensitivity of the columns to feed composition changes. It is apparent that the advent of the fractionating-absorber is a major development in light hydrocarbon processing.

Process Methods

While the fundamental process steps used for the recovery of liquifiable hydrocarbons — absorption, stripping, and fractionation—are the same in all plants, there are many variations in arrangement and operating conditions in profitable use throughout the industry. Generally, the incentive for devising what may be considered a new or different process scheme arises from some unusual conditions under which a plant is required to operate. Such conditions may include details ranging from a scarcity of cooling water to an uncertain supply of electrical power and such major matters as whether the feed stock is a dry or a wet gas available at a high or at a low pressure and whether the residue gas is to be sold or recycled to a formation. One way or another, the over-all economics of the situation will dictate most of the choices. Each new plant that is built is likely to include some new idea in processing. If the idea is especially good it will be used in other plants. Some variations that have appeared on the flow diagram of recent plants are noted below.

In Figure 4 is illustrated still another column employed for demethanizing rich oil in an absorption-type gasoline plant. This column, which was termed a "demethanizer-reabsorber" by the designer, is similar in appearance to demethanizing columns used in other plants, but has variations both in process flow and in operating temperatures. In this column rich oil from the base of the upper absorber section is withdrawn from the column, heated by exchange against hot lean oil, mixed with incoming rich oil from a primary absorber, and charged to the top tray of the lower stripping section of the column. A small stream of rich vapors from the plant's stripping still overhead accumulator is fed into the base of the

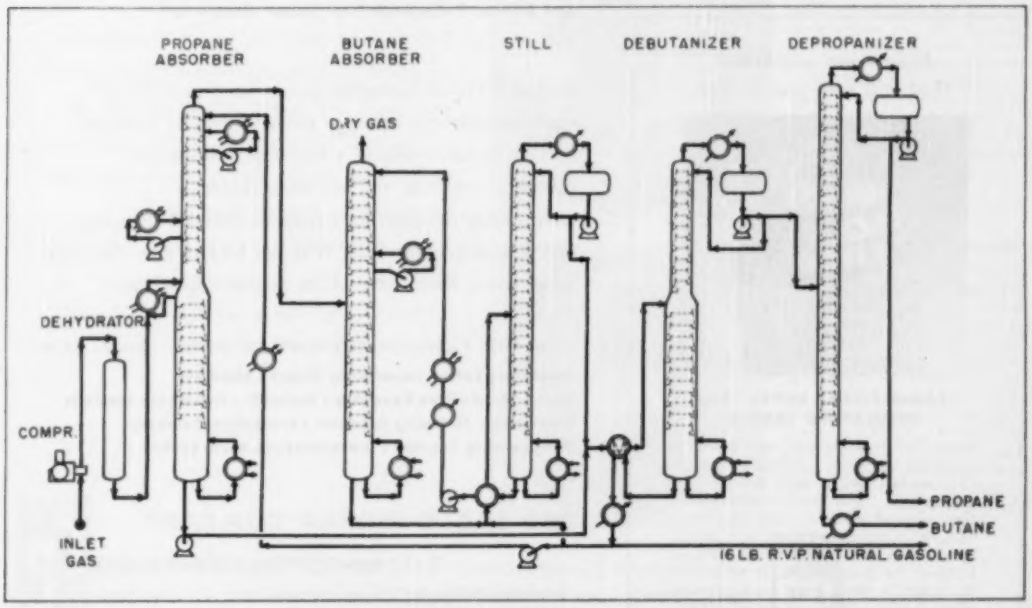


Figure 3. Simplified flow diagram of a process for a natural gasoline plant utilizing two fractionating-absorbers, recovered gasoline as absorption oil and refrigeration at two temperature levels.

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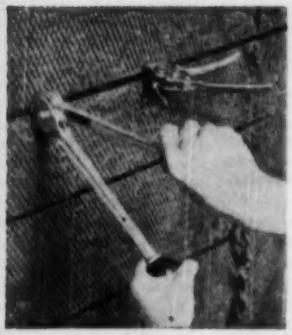

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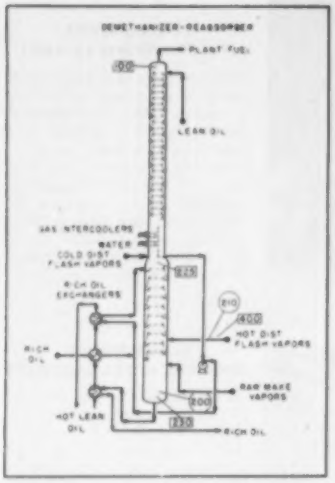


Figure 4. In this case, the column for methane removal is termed, demethanizer-reabsorber.

column as a stripping medium.

Heavier components of the stripping vapor selectively displace lighter components remaining in the rich oil flowing to the bottom of the column. Absorbed light gases are largely vaporized at the feed-tray flash zone, and the stripping section of the column operates with a quite small temperature gradient and at a comparatively low temperature level, thus making for good heat recovery from the lean oil system. "Intercoolers" cool the vapors entering the absorber section.

In the particular design shown vapor streams from two other plant sources are routed to this column which thus provides needed separation of product components from light gases. It is necessary, of course, that such vapor streams be injected into the column at appropriate points so that components they introduce will not upset the separation which the column would otherwise provide.

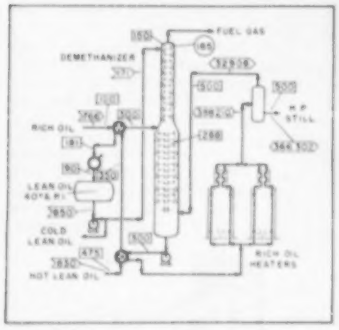


Figure 5. Demethanizer column using hot vapors for stripping.

The column illustrated in Figure 5 is a demethanizing column also; however, hot vapors are utilized in stripping. The heaters are for the rich oil charged to the high-pressure still. In this instance they are made to serve a second purpose—as reboiler for the demethanizing column by generating recycle vapors from the rich oil stream. This stream is rich in propane. In the column, the differences in partial pressures of the hydrocarbons cause propane to be absorbed preferentially by the rich oil in the stripping section, releasing methane and ethane from the liquid phase. These gases flow upward into the absorption section with the gases flashed from the stream of rich oil charged to the mid-section of the vessel. The column strips most of the methane from the rich oil, substantially reducing the volume of noncondensibles in the feed to the high-pressure still. In this plant, however, a certain amount of ethane is desired as a product, and the plant still is followed by a fractionator which produces ethane as an overhead stream.

Where methane and ethane are not substantially all rejected from the rich oil by means of one of the schemes available for the purpose, it is fairly common practice to provide a fractionating column to separate ethane from the raw natural gasoline make. This separation is necessary if propane of high purity is to be made. It is possible to operate these fractionators with plant cooling water as the condensing medium for overhead reflux, but it has been found that refrigeration at this point is often advantageous.

The composition of the overhead product and the temperature to which the reflux drum can be lowered by the available cooling medium set the pressure at which the tower must operate to condense reflux. The reboiler temperature for the tower is in turn set by tower pressure, and this temperature is limited, since too close an approach to the critical pressures of the bottoms product must be avoided if the tower is to function. Where high retention of propane, or a pure ethane product is desired, propane must not be a major component of the tower overhead vapor stream. Low temperatures are required to condense ethane alone as reflux, and refrigeration is thus essential unless plant cooling water temperatures are abnormally low.

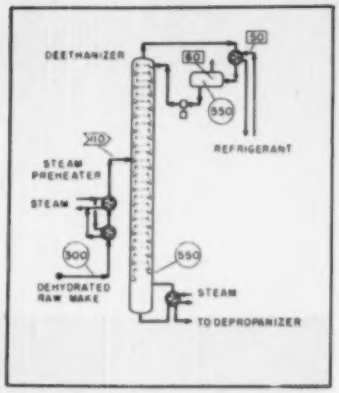
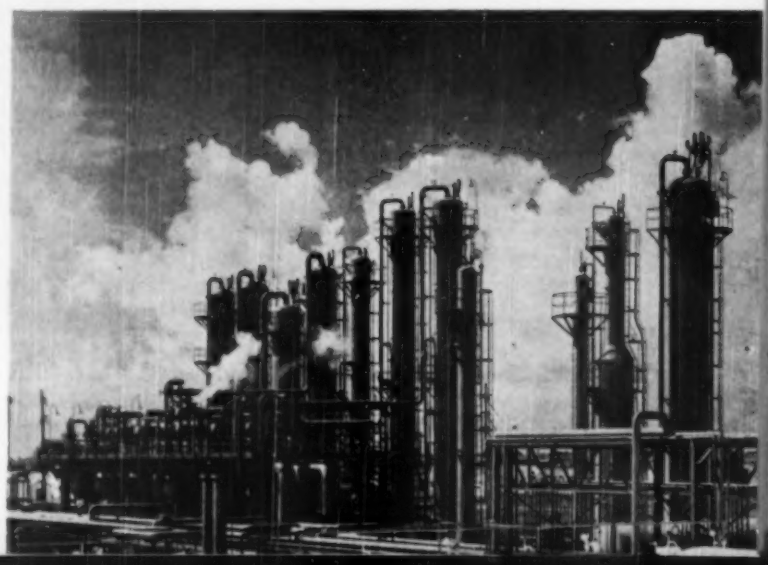


Figure 6. Deethanizer in a plant designed for 85 percent recovery of propane.

The column in the sketch of Figure 6 is operating in a plant designed for 85 percent recovery of propane. This recovery figure was easily reached and surpassed. The feed is completely demethanized and also dehydrated to prevent freezing in the overhead lines using refrigeration. Overhead vapors



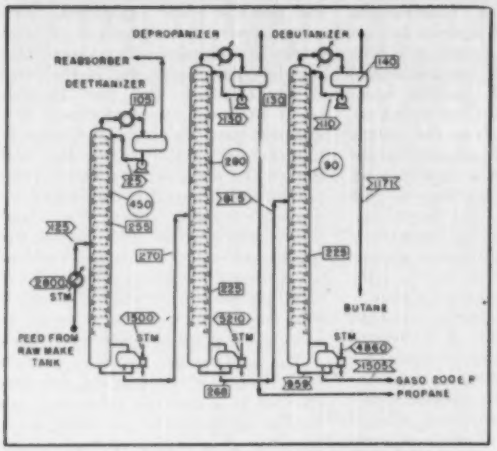


Figure 7. Simplified flow diagram showing the conventional fractionation channel used in most plants.

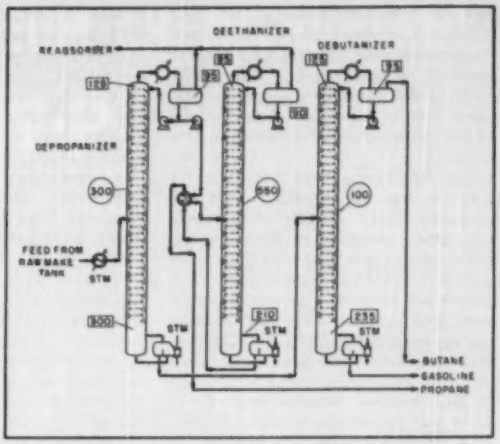


Figure 8. Fractionation scheme employed to avoid difficulties with critical temperatures of raw make mixture.

of the column consist substantially of ethane which is condensed at about 50° F. to provide reflux for sharp separation of the ethane from the propane and heavier material. What might be termed the conventional order of fractionation for the raw gasoline make in an absorption plant routes the feed first through a deethanizing column and then successively through a depropanizer and a debutanizer, Figure 7. These columns produce ethane, propane, and butane, respectively, as overhead products. The bottoms in each case flow on to the next tower with natural gasoline of the desired butane content being produced as the bottoms from the last column, the "debutanizer" which is, of course, often termed a "stabilizer." This order of separation has advantages from the standpoint of simplicity and economy of process utilities.

The high pressures necessary for reflux condensation for deethanizing columns necessitate high bottoms temperatures, especially in cases where considerable percentages of heavy components are present in the bottoms stream. High reboiler temperatures will present difficulties through a too close approach to the critical temperatures of the bottoms stream. The arrangement shown in Figure 8 has been employed to avoid these difficulties. In this plan the heavy components are separated as bottoms at a "depropanizer" column which makes an overhead condensate that is charged to the deethanizer.

The depropanizer pressure required to condense reflux and overhead product is not especially high and reboiler temperatures are thus reduced to moderate levels. Further, the critical temperature of the bottoms product is raised by the removal of its propane component. The deethanizer produces a propane bottoms product and rejects ethane gas overhead. The deethanizer has preheated feed and operates at a substantially higher pressure than the depropanizer. Fractionation is achieved with a temperature gradient of a little over 100° of temperature from bottom to the top of the column. Butane and gasoline from the bottom of the depropanizer are separated in the conventional manner. The scheme is most useful in plants where extremely high propane recovery is not essential. Although both the depropanizer and deethanizer show overhead vapor streams that are routed to reabsorption columns, the volume is not large.

Many gasoline plants are required to process feed stocks ranging from methane through kerosine and light gasoil. It is the usual practice to route production from both the natural gas

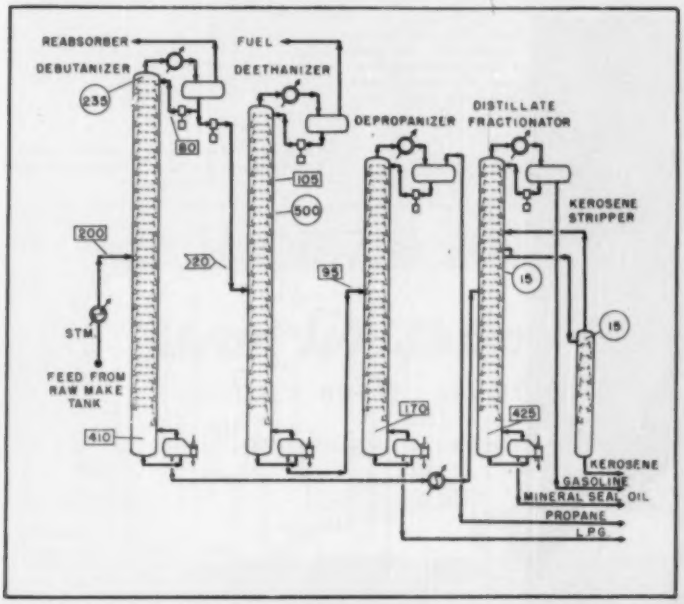


Figure 9. In this case, the "debutanizer" splits the raw make stream for further fractionation of both overhead and bottoms.

and the distillate wells of an area through a common plant. The heavy components thus brought into natural gasoline plants occasion little difficulty in the absorption section of the plant but do make for complications in the stripping and fractionation sections.

Because equipment requirements may be less in the absorption and stripping section if some of the process steps are made to accommodate both natural gas and distillate components, the total products of such plants are often recovered as a single combined stream. This raw product stream must be separated into its various components. Because the boiling range is quite wide the fractionation of this mixture presents some problems that are not encountered in simpler gasoline plants. The presence of heavy materials may eliminate consideration of the conventional process step order of deethanization, depropanization, debutanization or stabilization, and distillation of the heavy oil into fractions of desired boiling range. The reboiler temperatures necessary for satisfactory separation of ethane in the first tower would be high and the critical temperature of the wide range bottoms material is comparatively low.

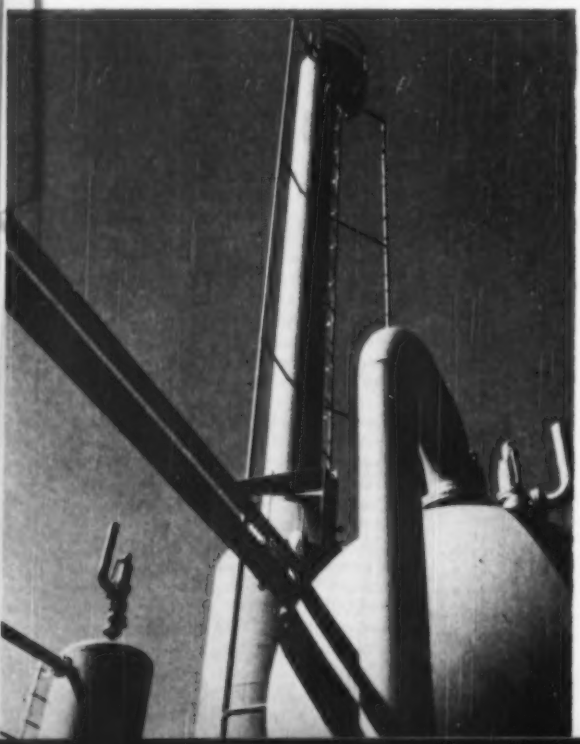
An alternate design that has been used in some plants is shown in Figure 9. In this arrangement the first tower, termed a debutanizer, functions to split the raw product mixture into an overhead stream composed of butane and lighter gases and a bottoms stream composed of natural gasoline, kerosine, and heavier distillate fractions. The overhead stream from the splitter tower is largely condensed and charged to a deethanizer and a depropanizer combination which functions in conventional fashion. A fuel gas is produced overhead from the deethanizer while a propane cut is the top product from the depropanizer and a LPG fraction the bottoms product. Gas noncondensable at the splitter overhead product accumulator drum is recycled to a reabsorber. Bottoms from the splitter tower are charged to a distillation column where gasoline is produced overhead, kerosine is a sidestream cut handled through a steam stripping section, and a mineral seal oil the bottoms product. This scheme provides easier and more efficient operation of the columns, allows use of a comparatively small deethanizing column, and smaller pumps and reboilers.

The recent trend of natural gasoline plants to produce and market premium motor gasoline, although following several courses, continues to progress. In some instances, catalytic reforming units for the heavier gasoline fractions to premium gasoline components have been included as part of the gasoline plant equipment. Such units require the separation of feed stocks of suitable boiling range. One such feed preparation unit is illustrated in Figure 10. In this case the first tower produces an unstabilized 200-endpoint gasoline overhead. Charge to this still is unstabilized gasoline and flashed raw distillate. The bottom temperature of this still is maintained by a recycle stream from a direct-fired heater which serves as preheater for the second tower. The heated bottoms are charged to the naphtha still. A small stream of absorption oil injected into the system provides a means of keeping the plant absorption oil clean.

The naphtha still overhead product is a 200-450° F. naphtha cut, which is charged to a catalytic reforming unit for the production of premium motor gasoline. A partition is used in the lower section of the naphtha still to divide the column into internal sidestream strippers with semicircular trays. The regular bottoms stripping section produces a gasoil product. The other half of the tower serves as a stripper for kerosine which is drawn off of a tray in the upper section of the still.

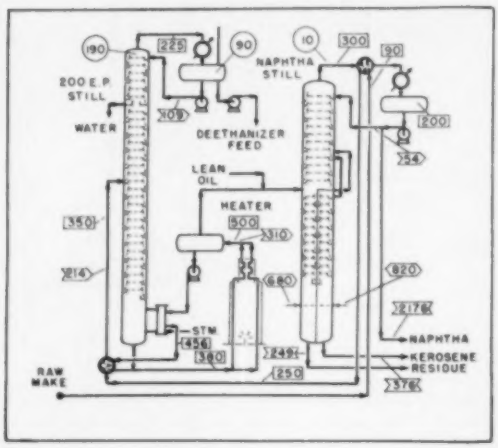
REFERENCES

[1] Whistler, A. M., "Fat Oil Deethanization," Petroleum Refiner, December, 1946.
[2] Hannah, J. C., "Fractionating Absorbers in the Petroleum Industry," Petroleum Refiner, August, 1949.
[3] Goldblatt, S., and Nelly, Jr., H. M., "Rich Oil Stabilization," Petroleum Refiner, November, 1949.
[4] Liljenstein, G. M., "Cycling Plants Stabilize Crude Oil," Petroleum Refiner, October, 1948.
[5] Kniel, Ludwig, "Propane Recovery by Absorption, California Natural Gasoline Association, October 8, 1948; Petroleum Refiner, November, 1948.



Left. The tall, slender column, with the upper section of reduced diameter, is a familiar sight in gasoline plants today.

Figure 10. Process scheme in gasoline plant to produce charge stock for reforming to premium motor gasoline.



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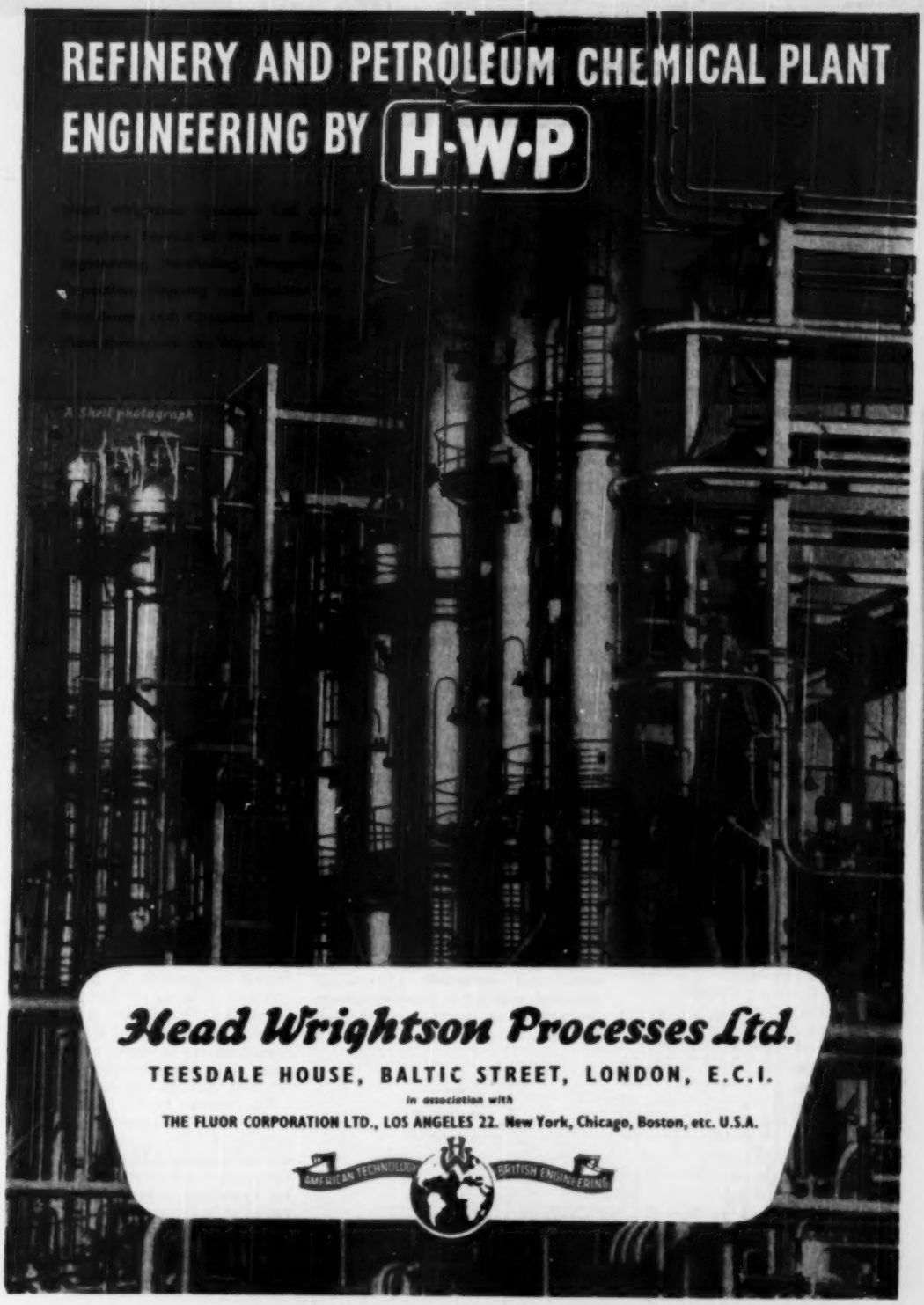

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New developments in the field now make it possible to produce as many as four separate gas streams of high purity from a single Hypersorption unit. The schematic drawing, Figure 1, illustrates a simple sidecut operation on a cracked gas feed. The flow diagram, Figure 2, illustrates the simple case in which two products are produced. It can be seen that the unit has three major sections: a cooling section at the top, an adsorption and rectifying section in the middle, and a steam stripping section at the bottom. A gas lift is employed to convey the granular charcoal from the bottom of the unit to the top in a closed cycle of circulation.

The feed gas enters through an engaging tray and passes upward countercurrent to the moving bed of activated charcoal. In its passage through the bed, the heavier compounds are adsorbed and retained on the charcoal. The top product gas, comprising the lightest constituents in the feed, disengages from the charcoal below the cooler and passes off through a cyclone. The charcoal passes downward below the feed point to the rectifying section where it contacts a reflux of heavy constituents, separated in the stripper, which serves to liberate lighter constituents adsorbed on the downward-moving charcoal. A concentration of these latter constituents in the vapor phase results and if desired they can be disengaged as a sidecut product gas at a point between the feed and bottom product gas disengaging sections. As the charcoal flows past the bottom product gas disengaging section into the steaming section, it meets an upward flow of steam which liberates the adsorbed heavy components, and these flow upward either to return as reflux or pass out as bottom product gas from the Hypersorber.

The charcoal flows from the steaming section into the stripping section wherein it passes down through tubes, which are heated on the outside by condensing Dowtherm, and through which steam is passed countercurrent to the charcoal. The hottest point in the stripper is at the bottom of this section and substantially all residual adsorbed material is removed during the passage of the charcoal through this zone.

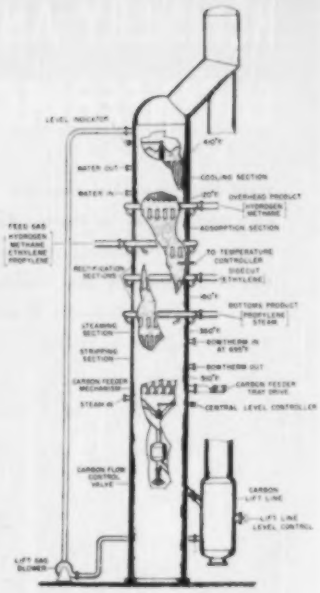


Figure 1. Hypersorber with sidestream.

The flow of charcoal leaving the stripper is controlled by means of a specially designed reciprocating feeding mechanism which drops the charcoal into a sealing leg in which a level is maintained to restrict the flow of steam into the charcoal lift.

A charcoal regeneration unit is provided to act in parallel with the Hypersorber for the purpose of carrying out high-temperature steam treatment of the charcoal to maintain its activity.

The charcoal is transported to the top of the tower by means of the gas-lift and is dropped into the reserve charcoal hopper at the top of the unit. The hot charcoal passes down from the hopper into the cooling section consisting of a tube-and-shell exchanger wherein the charcoal is cooled to the desired temperature for adsorption.

A part of the top product gas stream from the Hypersorber passes up through the cooler and hot charcoal hopper serving to remove any residual water and steam remaining on the charcoal from the stripping operation.

The extended field of light gas processing, which Hypersorption makes possible, includes the recovery of ethylene and propylene from refinery gases and gases from high temperature cracking operations, separation and purification of hydrogen, recovery of acetylene in low concentration gas streams, recovery of ethane and propane from natural gas, and the separation of nitrogen from natural gas.

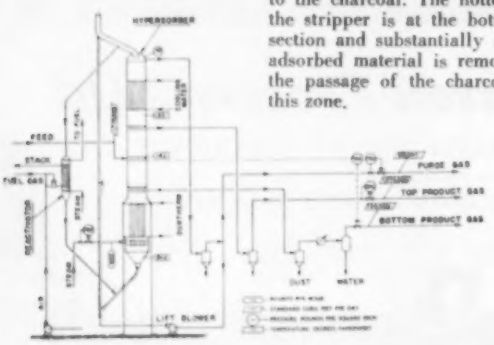


Figure 2. Diagram of simple Hypersorption unit.

Autothermic Cracking For Ethylene Production

R. M. DEANESLY
Universal Oil Products Company, Chicago, Illinois

AUTOTHERMIC CRACKING is the name given to processes in which the heat of cracking is provided by air or oxygen introduced with feed rather than by external firing of tubes.

It has been applied primarily to cracking for ethylene production because it enables the high temperatures in the region 1700-1800° F. to be reached which are favorable to fast reaction and good yield.

The amount of feed stock which is burned by the introduction of air to provide the heat of cracking, as well as the amount of air required, is minimized by the employment of efficient heat exchange between the effluent gases leaving the cracking zone and the air and hydrocarbon streams entering. Thus the extent of dilution of the effluent gases by nitrogen from the air and carbon oxides from the combustion reactions is low enough so that it is in general not economically justifiable to employ oxygen.

The flow sheet shows schematically the application of the process to ethylene production from ethane or propane or any available refinery or natural gas streams containing more than 50 percent by volume of components heavier than methane.

Fresh hydrocarbon feed and recycle streams, if any, are introduced into the series of heat exchangers 3, 5, 6, and air from the compressor into the heat exchangers 1 and 2, where they are preheated by effluent gas. The two streams, preheated to around 1300° F. and at a pressure of 25-30 psig. are mixed at the entrance to an insulated refractory-lined reactor. The mixture rises rapidly to around 1700-1800° F., after which the endothermic cracking reactions overtake the nearly completed combustion reactions, and the temperature falls progressively to around 1500° at the exit of the reactor. Effluent gas from the reactor is split into two streams, the main stream passing through exchangers 6, 5, 4, and 3, and the minor stream through 2 and 1, after which it rejoins the main stream. An adjustable valve on this minor effluent stream controls its proportion. Exchangers 4 and 7 are used to reheat the effluent gas stream, after the water cooling to remove water, aldehydes, and traces of acid. An adjustable by-pass controls the temperature of the reheated stream, going to the acetylene hydrogenation catalyst. A small amount of alkali injection serves to neutralize traces of formic acid in the gas.

The extent of cracking (i.e. conversion per pass) and the temperature levels through the reactor and exchangers vary directly with the air-hydrocarbon ratio. Thus air-hydrocarbon ratio is the primary controlling variable in any given operation. The typical range of this variable is illustrated in Table 1. With the autothermic technique it is practical to carry out the cracking of ethane at levels of more than 90 percent conversion per pass, thus minimizing the load of the recovery plant and the extent of recycling.

Yield of ethylene from ethane declines somewhat with increase of conversion per pass from around 0.8 mols per mol of ethane reacted at 50 percent conversion to around 0.6 mols per mol reacted at 90 percent conversion. But in view of the usually lesser importance of the raw material in over-all operating cost in comparison with the capital investment, it is generally preferable to carry out the process at a conversion level in the region of 80 percent where the concentration of ethylene in the raw product gas is at a maximum. This minimizes the size of recovery plant.

Acetylene in the raw product gas varies with conversion level (or reaction temperature) from a trace at 50 percent conversion to 1 part per 100 of ethylene at 75 percent conversion and 4-6 parts at 95 percent conversion. It is destroyed by passage of the raw product gas over a selective hydrogenation catalyst, a step which also eliminates traces of butadiene. The reheating of the gas for passage over the acetylene removal catalyst is preferably arranged within the heat exchange system of the reactor as shown in the flow diagram.

The raw product gas also contains traces of formaldehyde and acetaldehyde and smaller amounts of the corresponding acids. The aldehydes are largely removed in the aqueous condensate and the remainder in the water scrubbers before and after compression. The traces of acid are neutralized by the small amount of alkali solution introduced, and pass out with the aqueous condensate.

The production of ethylene by autothermic cracking was the subject of a paper by Messrs. R. M. Deanesly and C. H. Watkins at the AIChE Spring meeting in Houston February 28, 1950.

Autothermic cracking is a development of Universal Oil Products Company.

TABLE 1

Air-Hydrocarbon Ratios for Autothermic Cracking of Ethane and Propane

Hydrocarbon conversion %*	50	70	90	95
Air-Hydrocarbon volume ratio in feed				
Air/Ethane	0.8	1.2	1.6	1.7
Air/Propane	0.7	1.0	1.4	1.5

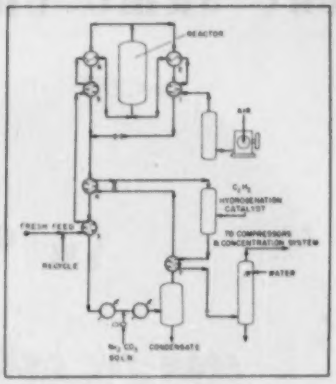
* i. e. Over all reaction = (100—surviving C_2 or C_3).

TABLE 2

Representative Analyses of Autothermic Effluent Gas

FEED	Ethane		Propane		#/## Methane/ Ethane
Air/HC Vol. Ratio	0.8	1.4	0.6	1.2	0.9
Conversion*	52.6	81.9	48.1	79.5	78
Product Gas Analysis†					
H_2	15.8	19.8	5.8	9.6	18.3
CH_4	2.7	5.9	11.6	17.3	19.0
C_2H_2	0.05	0.3	0	0.3	trace
C_2H_4	19.6	21.3	12.5	18.0	16.7
C_2H_6	22.1	6.6	0.8	1.1	5.3
C_3H_6	0.7	0.6	5.6	5.1	0.3
C_3H_8			24.3	7.2	0.1
C_4	.05	0.4	0.8	1.1	0.2
C_5	0	0	0	0.10	0
CO	2.1	4.5	4.2	4.9	5.5
CO_2	2.8	2.3	2.1	2.5	2.1
N_2	34.1	%38.3	28.3	32.8	32.5

* 100—Percent unreacted C_2 or C_3.
† Excluding H_2O.



Flow diagram of Autothermic Cracking process.

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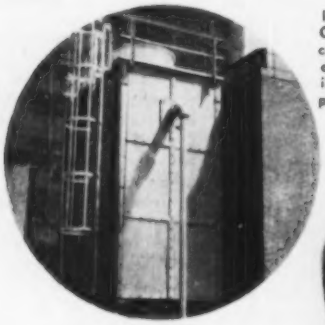
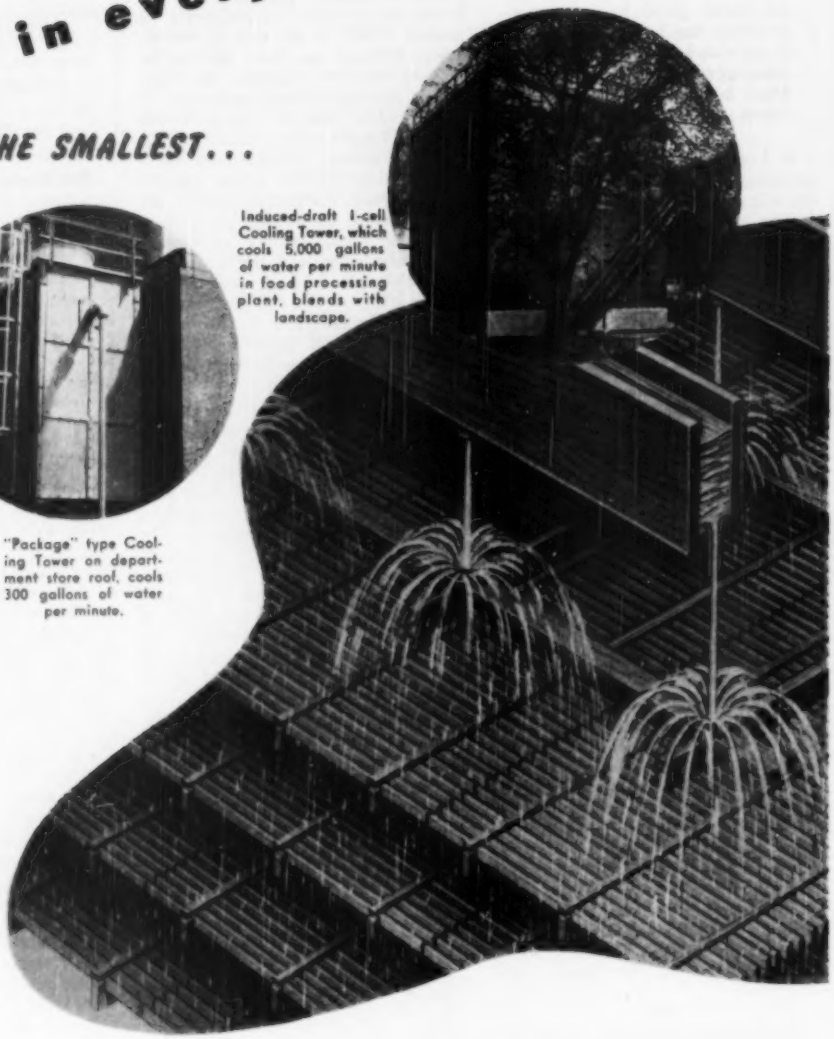


"Package" type Cooling Tower on department store roof, cools 300 gallons of water per minute.

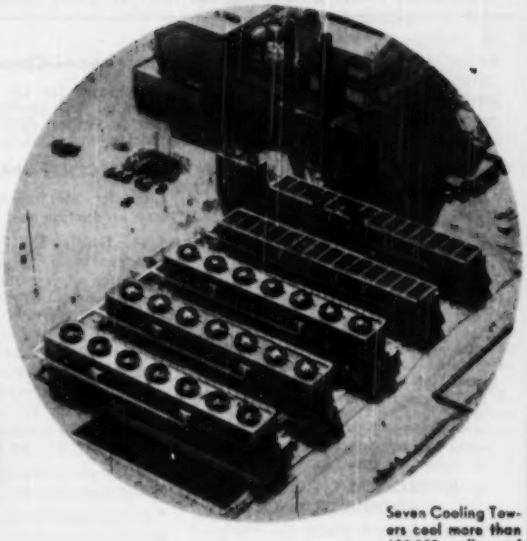
Induced-draft 1-cell Cooling Tower, which cools 5,000 gallons of water per minute in food processing plant, blends with landscape.



FOSTER WHEELER CORPORATION 165 BROADWAY

cooling tower

Induced-draft 6-cell Cooling Tower in oil refinery cools 10,300 gallons of water per minute.



Seven Cooling Towers cool more than 180,000 gallons of water per minute in large power plant.

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Whatever the application—a "package" type on a department store roof in New York City, a twenty-cell tower for a power plant in Arkansas, or a large unit for a chemical plant in India, Foster Wheeler Cooling Towers can be depended on to deliver full capacity in year-round service.

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Many types and sizes of commercial carbon dioxide plants are designed and built by Girdler. Production of any desired quantity may begin with gas, oil, coke or coal as fuel. Also, recovery can be made from gas mixtures, such as kiln gas, chemical process gas, etc. In either case carbon dioxide may be delivered as palatable gas or liquid, or in solid form as dry ice.

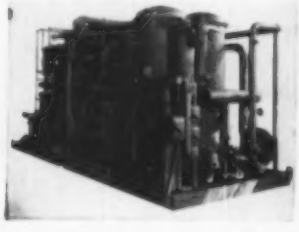
Small, self-contained plants that use oil or gas as fuel are available in two standard models. They have rated capacities of 150 and 300 pounds of gaseous or liquid carbon dioxide per hour. Write for complete information.

HYDROGEN CHLORIDE PRODUCTION

Girdler designed plants for the production of anhydrous and aqueous HCl are based on a commercially proven process. Direct reaction between H_2 and Cl_2 produces exceptionally pure HCl in high yield at low cost. The H_2 may be made from natural gas or propane in a Girdler HYGIRTOL plant. In such cases the cost of manufacturing HCl is little more than the cost of Cl_2 consumed. Plant capacities are determined by individual requirements.

CATALYSTS

The refinery, chemical and gas industries regularly use Girdler catalysts in many phases of their operation. Catalyst development, testing and manufacturing are done in a well-equipped laboratory and plant. All work is under the direction of expert technicians. Submit details for the solution to your catalyst problems.



Above: This semi-portable plant manufactures 300 pounds of high-purity liquid carbon dioxide per hour. It is only 9 feet wide, 22 feet long and 11 feet high. Portable and semi-portable units of this type have also been developed by Girdler for producing hydrogen and for the dehydration and desulfurization of gases.

Right: Exterior of a Girdler nitrogen unit using natural gas for the raw material.

HYDROGEN MANUFACTURING

Girdler offers several types of hydrogen production and purification plants.

The Girdler HYGIRTOL Plant, a recent development, produces high-purity hydrogen at a remarkably low cost. By reacting hydrocarbons with steam over suitable catalysts at elevated temperatures, the hydrocarbons are converted to carbon oxides and hydrogen. Carbon monoxide and steam are then reacted catalytically to produce hydrogen and carbon dioxide. With successive purification steps, hydrogen of extremely high purity (99.9%) can be obtained.

Other processes use coke or methanol as the raw material.

Carbon dioxide may be recovered as a usable by-product of each process. About 250 cubic feet are produced for each 1000 cubic feet of hydrogen.

Write for the new Girdler book, on Hydrogen. It contains pertinent facts about most manufacturing and purification processes.

THE GIRBOTOL PROCESS

This process, originated by Girdler, is a simple cyclic process for removing and recovering acid gases, such as hydrogen sulfide and carbon dioxide, from gaseous mixtures and liquid hydrocarbons.

This is the most effective process of its kind known, and over 200 successful installations are now in use in the refinery, natural gas and chemical fields. Simultaneous purification and dehydration may be effected if desired. Operation is substantially automatic. Reagent losses and utility consumption are low.

DEHYDRATION

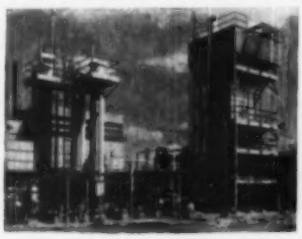
Processes are available for the dehydration of liquid hydrocarbons as well as gases. As required, liquid or solid agents, refrigeration or combinations of them are employed.

The Girdler Automatic Gas Dehydration Unit now makes it thoroughly practical to remove water vapor from natural gas at the well. No operator is needed and the only utility is a small amount of the gas. Complete information on request.

GET GIRDLER ON THE JOB

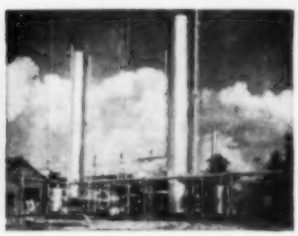
Girdler designs and builds many different types of plants for the refining and chemical industries—has developed a number of widely used chemical processes—is licensing agent for several additional processes. Recovery, purification and use of by-product gases is a specialty. Girdler's research department can conduct laboratory and pilot plant tests of processes in preliminary stages of development. Data they secure will be translated to design details for your final plans. Consult with Girdler on your chemical processing problems.

HYGIRTOL—is a trade mark of The Girdler Corporation.



Left: A Hygirtol plant for producing high purity hydrogen from hydrocarbons and steam.

Below: An installation for the removal of hydrogen sulfide from natural gas by Girbotol Process. Similar plants are extensively used for removing hydrogen sulfide from refinery gases and liquids and for the removal and recovery of carbon dioxide.



Acetylene Manufactured by Electric Discharge in Schoch Process

L. S. DANIELS, Editor

ACETYLENE is of great importance as an intermediate for a wide field of organic chemicals manufacture. In this country, however, much of our chemicals manufacturing activity has been based upon ethylene because it has been available at rather low cost from plentiful supplies of petroleum liquids and gases. In Europe, where petroleum is scarce, acetylene obtained from coal and limestone has served as the principal starting point for organic synthesis.

There are valuable organic products that can best be made by the acetylene route. Many of the synthetic products which can be derived, starting with acetylene, are difficult or even impossible to make from any other raw material. Accordingly, the development of more economic processes for making acetylene can lead to great expansion of our chemicals manufacturing industry.

PETROLEUM gases and liquids are readily available in many parts of the U. S. and comparatively inexpensive. As a result there has long been an interest in the development of practical processes for the manufacture of acetylene from petroleum feed stocks.

Several schemes have been devised. In these processes methane or higher hydrocarbons are raised to quite high reaction temperatures for a very short time. Methods for supplying the large amount of energy absorbed in the reaction include electric discharge through the gas, the use of an auxiliary fuel in either indirect heat exchange or in a regenerative furnace, and the direct heating of the gas by partial combustion with injected oxygen.

In locations where cheap electricity as well as petroleum hydrocarbons are available, the electric discharge method is promising. In this country pilot plant research in glow discharge acetylene manufacturing methods has been conducted by E. P. Schoch and his co-workers at the University of Texas for several years. Their process, now at the planning stages of commercial development, has recently been the subject of a report, "Acetylene from Hydrocarbons," by the staff of the university's Bureau of Industrial Chemistry, Acetylene Division, at Austin, Texas.

The hydrocarbon feeds employed with the Schoch process for acetylene manufacture may be either gases or liquids with only slight modification in plant designs. A gas feed may be wholly of methane (natural gas) or partly or wholly of higher hydrocarbons (propane—butane mixtures). A liquid feed may be composed of vaporizable hydrocarbons whose 100-percent flash-vaporization temperature, under a partial pressure of one-half atmosphere, is below 550° F. This includes the petroleum fractions ranging from those in gasoline to those in diesel fuel.

The process is basically simple, Figure 1. The hydrocarbon feed is exposed to a glow discharge for an extremely brief interval of time. Conversion to acetylene and other product gases takes place during this interval. The reaction gases are removed from the glow discharge zone and separated. Heavy gases are recycled for further reaction, light gases routed to fuel, and purified acetylene sent on to sales or other use. The process is continuous, automatically controlled, and does not involve tanks or gasometers for acetylene storage.

The Schoch process plant involves four principal sections; electrical supply and regulation, gas reaction by glow discharge, separation of the C_2 and heavier hydrocarbons, and concentration of the acetylene fraction from absorber residue gases containing the two carbon and lighter materials.

The first section, power supply and control, normally will be based on a 60-cycle 3-phase alternating current

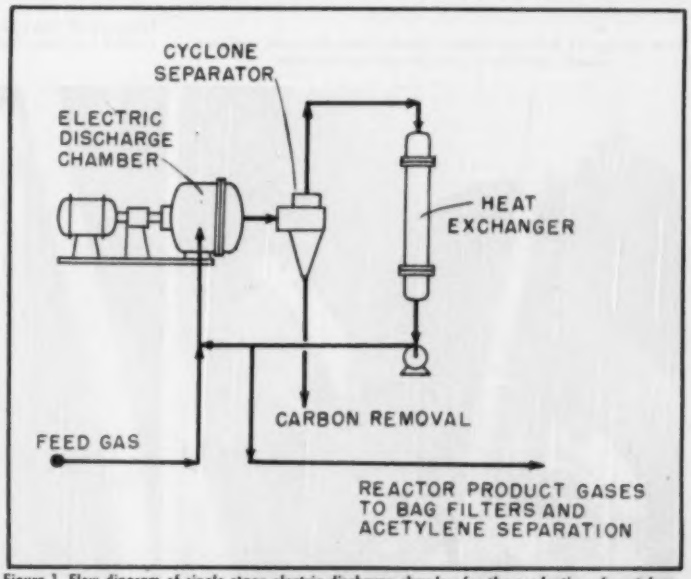


Figure 1. Flow diagram of single stage electric discharge chamber for the production of acetylene from natural gas feed stocks.

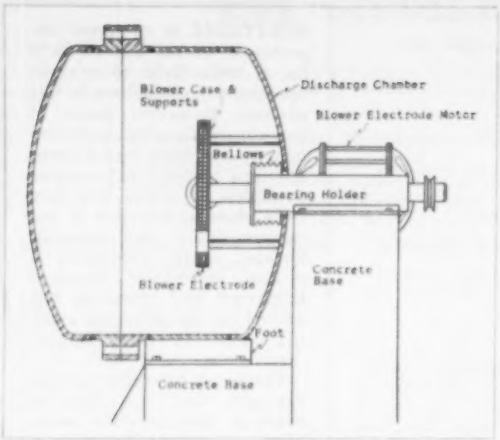


Figure 2. Section of typical electric discharge chamber showing arrangement of blower electrode in closed pressure vessel.

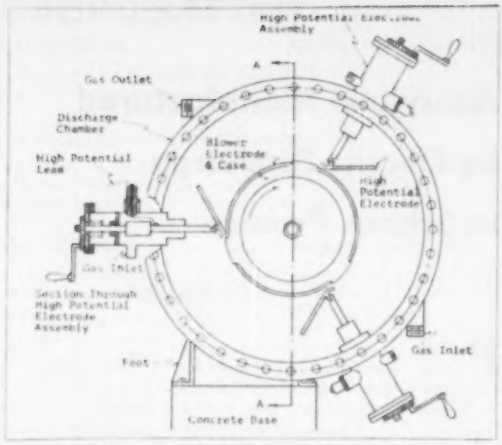


Figure 3. Arrangement of three adjustable but non-rotating electrodes about a central rotating blower electrode.

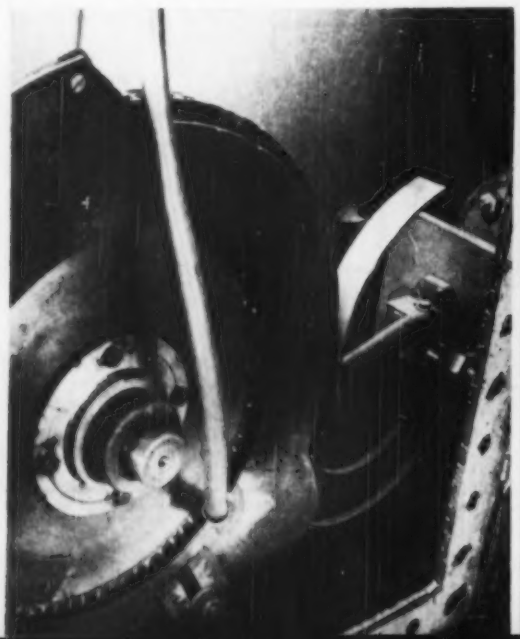
source. A Y-connected transformer supplies 3 pairs of lines for power supply to spark discharge electrodes. To utilize a 3-phase power supply three discharges are provided — or multiples of 3 may be used. The current for each discharge must be separately controlled. It is desired that this current be held at a fixed amperage regardless of the "path" length (or voltage drop). Capacitances and inductances are used to provide this control.

The glow discharge section is the heart of the Schoch acetylene process. Since the glow discharges are arranged in multiples of 3, the least number of reaction chambers in a plant may be one, with 3 discharges arranged in it. Alternately 3 chambers with one discharge in each may be used.

Each reaction chamber is a closed vessel. In a typical design, Figure 2, 3 non-rotating but adjustable electrodes are positioned about a single rotary blower electrode. The rotary electrode, which resembles the impeller of a centrifugal blower, is surrounded by a close-fitting stationary sheath. The rotary electrode serves to move a large volume of gas past the non-rotating electrodes thus bringing the feed stock into the spark discharge areas and also providing for heat removal from the electrodes by transfer to the moving gas stream. The rotary electrode is provided with more than the usual number of blades and vanes which are also relatively thick. These serve to conduct heat away from the glow discharge areas for transfer to the gas, preventing temperature damage to the electrode.

It takes about 1.6 pounds of a gas or 2.15 pounds of a liquid hydrocarbon to make a pound of acetylene. When hydrocarbons higher than

View into opened discharge chamber showing rotary electrode, stationary sheath, and one of the non-rotating electrodes.



Edge view of rotary electrode. Heavy vanes and blades serve to rapidly conduct heat away from the discharge zones, preventing damage to the electrodes.

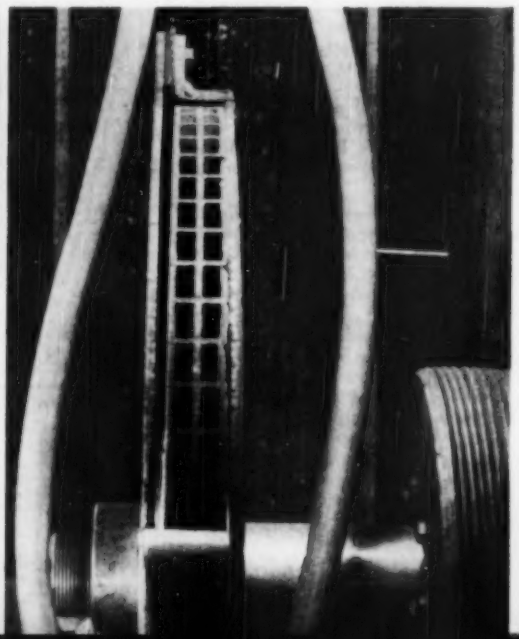


TABLE 1

Single Discharges for Illustration Control Equipment Ratio

DISCHARGE			SUPPLY		LBS. C_2H_2 PER HOUR	
Power Kw.	Potential Volts	Current Amps.	Potential Kv	Current Amps.	From CH_4 at 4.89 Kwh./Lb.	From Liquids at 3.55 Kwh./Lb.
100	4170	32.0	7.55	13.8	20.4	28.2
200	5030	53.0	9.10	22.8	40.9	56.3
400	6370	83.7	11.54	36.0	81.8	112.7
789	8520	123.5	15.43	53.1	161.2	222.3
815	8540	127.3	15.45	54.7	166.7	229.6

TABLE 2

Disposition of 6 kwh. in Plants Having Different Numbers of Discharge Chambers in Series and Producing 10 Percent Acetylene in the Product Gas

(Values approximate—for illustration only)

No. of Units	Kwh. in Product	Kwh. in Heat to be Removed	Kwh. Removed By 1 Pass through All Coolers	Average Volume to be Recirculated Through Each Cooler—Expressed as Fraction of Feed Gas
1	2.06	3.94	0.52	6.50
3	2.20	3.80	1.57	1.40
6	2.40	3.60	3.14	.27
9	2.43	3.57	>3.57	0.00

ethane are employed they are completely used up because these plants recover the C_3 and higher compounds and return them directly to the discharge chamber. For these, the original cost of the hydrocarbon charge determines the cost of the acetylene.

With methane and ethane feed this is not the case. The ethane is partly recovered but none of the methane is thus recovered. When a 10-percent acetylene product is made, only about one-third of the methane in the feed is decomposed in its passage through the plant. Two-thirds of it will pass out of the plant together with the hydrogen formed and the other non-hydrocarbon constituents. When produced from nearly pure methane this "off-gas" will have a composition of 55.5 percent methane (plus a little ethane) and 44.4 percent hydrogen. One thousand cubic feet of methane feed gas produces about 1200 cubic feet of this off-gas. The total heat units of the off-gas represent about 82 percent of those in the feed. A portion of this heat value is needed in the plant but most of it will be available for other uses. The heating power of the unused gas is fully enough to produce the electric power for the plant.

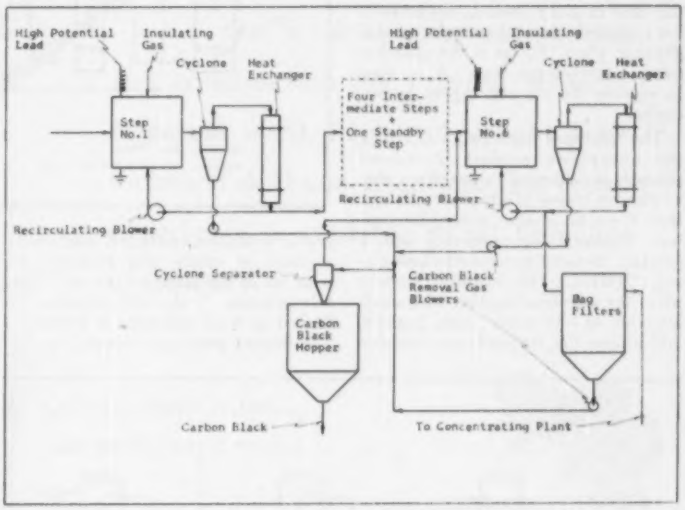


Figure 5. Flow diagram of six step electric discharge acetylene plant operating on natural gas feedstock.

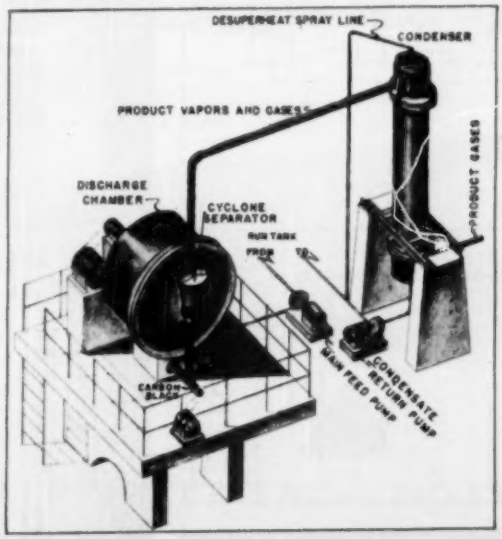


Figure 4. Single electric discharge chamber with accessory items. This equipment is arranged for operation on liquid hydrocarbon feedstocks.

The amount of acetylene produced per kilowatt hour increases with the number of discharge chambers through which the gas passes serially until it is converted to the desired extent (say 10 percent acetylene). About 60 percent of the discharge energy is liberated as sensible heat and this must be removed to limit the chamber temperature to 550° F. In general this is accomplished by recirculation through a cooler. When the gas is passed through a series of discharge chambers and coolers the need for recirculation is decreased with increase in the number of chambers and coolers and finally becomes zero. Table 2 shows how 6 kwh. of discharge energy is divided into product forming energy and waste heat when plants are operated with different numbers of discharge chambers in series.

An assembly of a single gas discharge chamber and its accessory equipment is shown in Figure 4 while a six step gas feed reaction unit is shown in Figure 5.

A small amount of carbon black is one of the reactor products. It is removed from the reacted gas stream by the use of a cyclone separator and cloth bag filters. Each cooler is arranged so that water cooled surfaces are constantly scraped to prevent their being covered with carbon black. The carbon black is collected and discharged from the plant.

The separation of the C_2 and heavier hydrocarbons from the acetylene and lighter gases is accomplished in a section that in many respects resembles a conventional absorption type natural gasoline plant, Figure 6. An absorber using a petroleum lean oil is used to remove the C_2 and higher hydrocarbons.

The absorber tail gas, containing the acetylene product, is passed through a charcoal absorption step to remove traces of absorber oil, and then flows to another absorption system, Figure 7 for contacting with a solvent, di-methoxy-tetra-ethylene-glycol, "DMTG." This material absorbs all of the acetylene together with small amounts of the other gases present, and allows the stripped gas—consisting of hydrogen, methane, and small amounts of ethane and ethylene—to pass out of the plant as "off-gas." The solvent-gases "rich oil" mixture is flashed to near atmospheric pressure. The flashed gases are recycled to the reaction section, and the liquid flows to a "purifying" column where the remaining amounts of methane, ethane, and ethylene are removed by "stripping with acetylene." The solvent liquid finally is heated to release the absorbed acetylene.

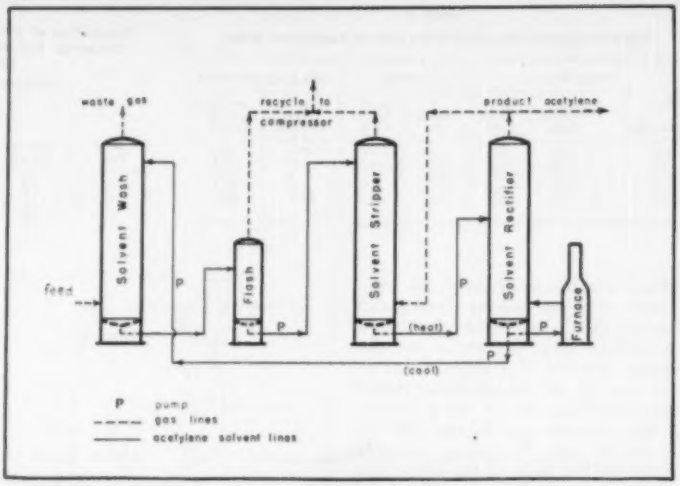


Figure 7. Plant equipment for concentrating the acetylene in the light gas stream. A special solvent is used for acetylene absorption. Separated gases are recycled to the reaction section.

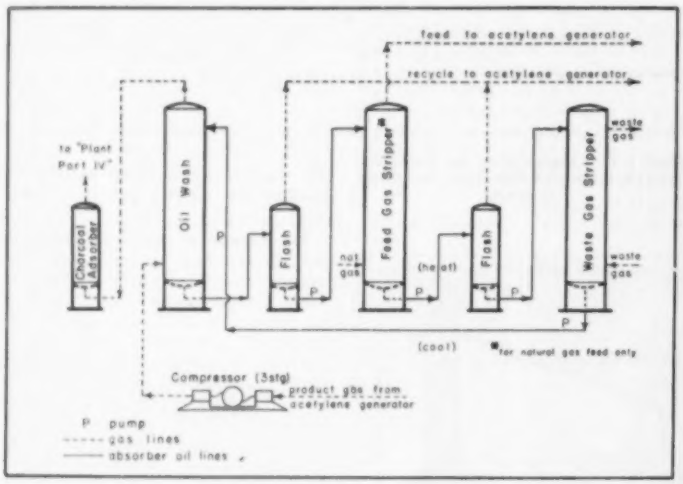
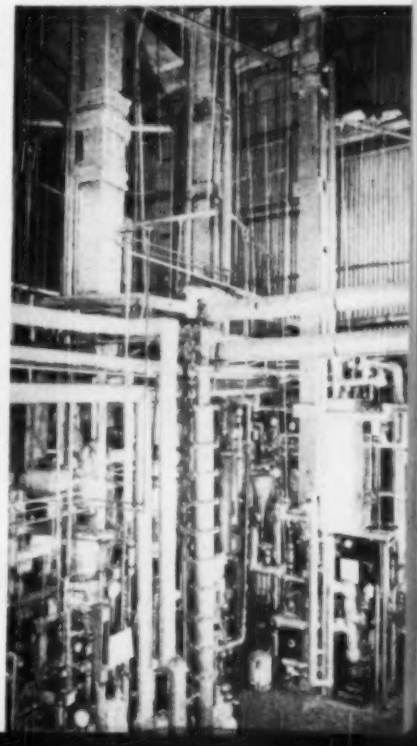


Figure 6, lower left. Equipment for removing the C_2 and heavier hydrocarbons from the reactor product stream. A petroleum fraction serves as absorption oil.

TABLE 3
Analyses (in Mol %) of Product Gases from Various Feed Gases

FEED	H_2	CH_4	C_2H_2	C_2H_4	C_2H_6	Methyl Acetylene	C_3H_8	Di-Acetylene	Vinyl Acetylene	C_4H_{10}
Methane	39.3	48.9	10.0	1.0	....	.2	....	.4	.2	....
	47.2	38.7	12.0	1.2	....	.2	....	.5	.2	....
	55.1	28.3	14.0	1.4	....	.3	....	.6	.3	....
Ethane	31.1	2.3	10.0	2.3	5.33	.3	....	.5	.2	....
	37.3	2.7	12.0	2.7	44.1	.3	....	.6	.3	....
	43.5	3.0	14.0	3.0	35.1	.4	....	.7	.3	....
Propane	32.8	3.2	12.0	3.2	1.5	.5	46.1	.6	.3	....
	38.3	3.8	14.0	3.6	1.7	.4	37.2	.7	.3	....
	43.8	4.4	16.0	3.9	2.0	.4	28.3	.8	.4	....
Butane	30.6	3.4	12.0	3.5	1.5	.3	....	.6	.3	47.8
	35.7	4.2	14.0	3.9	1.7	.4	....	.7	.3	39.1
	40.8	5.0	16.0	4.3	2.0	.4	....	.8	.4	30.3



View of pilot plant sections where acetylene separation and concentration operations are conducted. No tanks or gasometers for acetylene storage are required.

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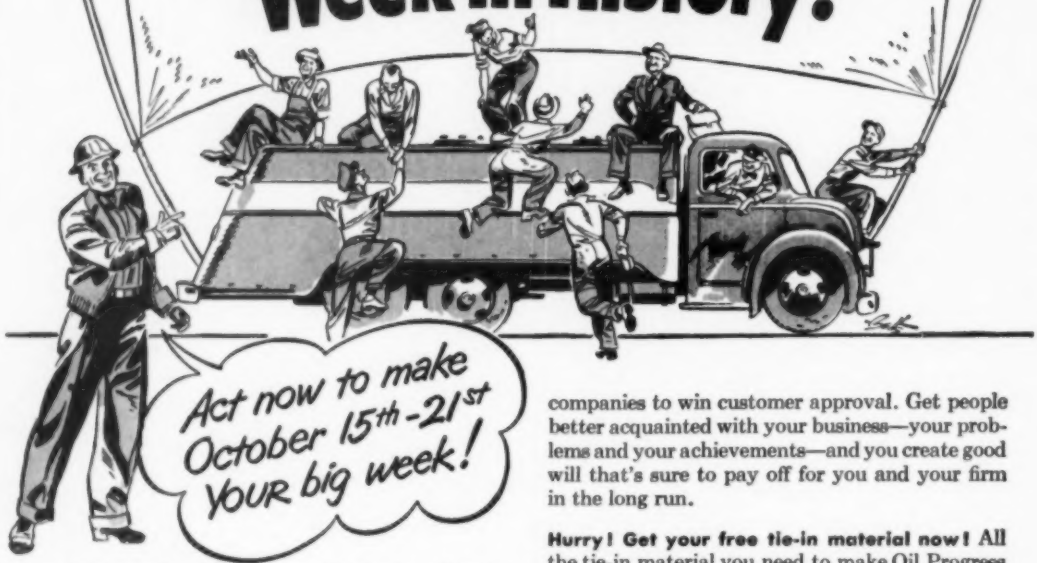

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Sulfur Produced From Hydrogen Sulfide

GIRDLER CORPORATION
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MANY natural gas, refinery gas, and liquid hydrocarbon purifying operations yield by-product hydrogen sulfide either alone or in combination with carbon dioxide. Disposal by the usual means of venting, flaring or burning under a boiler not only creates an air pollution problem but also wastes a valuable raw material. In view of the present depletion rate of known mineral sulfur deposits, this latter has become an important consideration. An economical solution to these problems may be found in the conversion of hydrogen sulfide to elemental sulfur by means of a process offered by The Girdler Corporation of Louisville, Ky.

Although the acid gas stream from a Girbotol plant is an ideal feed material, almost any H_2S or H_2S and CO_2 gas mixture may be employed. Generally a minimum of 90 percent of the sulfur present in the H_2S may be recovered in a two-stage plant, and up to 95 percent recovery is readily attained in commercial practice. However, a single-stage plant, designed to recover 80 percent to 85 percent of the H_2S as sulfur, may prove more economical in smaller capacity installations. The quality of the product is equal to or better than bright Gulf Coast sulfur.

The Girdler sulfur recovery process is based on a modification of the original Claus process for carrying out the highly exothermic reaction:

$$H_2S + \tfrac{1}{2}\ O_2 \rightarrow S + H_2O$$

In order to remove the heat generated more efficiently and maintain better control over the process the above reaction is carried out in two steps as follows:

$$(1)\ H_2S + 3/2\ O_2 \rightarrow SO_2 + H_2O$$
$$(2)\ 2H_2S + SO_2 \rightarrow 3S + 2H_2O$$

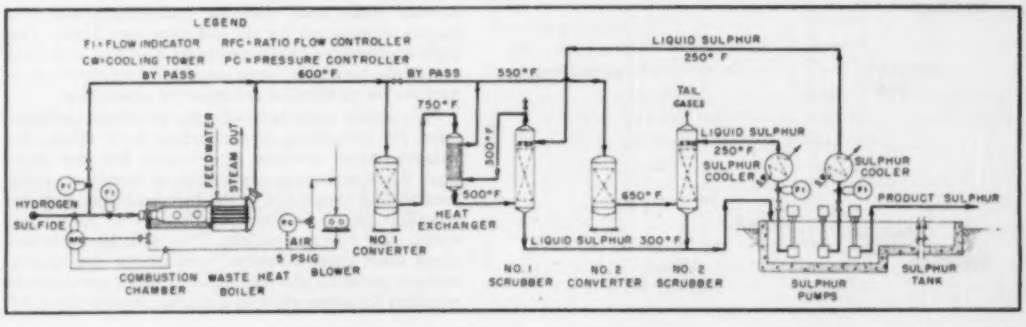
A typical flow plan for a two-stage plant is shown with the approximate temperatures indicated for a feed gas containing 90 percent H_2S or higher. Reaction (1) takes place in the combustion chamber of a waste heat boiler where approximately one-third of the H_2S is burned to SO_2 and steam is generated in proportion to the H_2S burned. This may vary from one to two pounds of steam per pound of sulfur recovered, depending on the composition of the gas mixture, pressure of steam desired, and boiler efficiency. If more than one-third of the feed gas is introduced into the boiler, some sulfur may be formed according to reaction (2). This reaction is also exothermic and will result in the generation of additional steam.

However, if hydrocarbons are present in the H_2S-bearing gas, it is important that complete combustion of those introduced into the boiler takes place there to avoid carbon deposition in the converters. In this case, not more than one third of the gases should be burned under the boiler with the correct quantity of air for complete combustion. The flow sheet shows a sealed refractory-lined chamber connected with a fire-tube waste heat boiler in this service. However, other types of gas fired boilers with a combustion chamber designed for a slight positive pressure may be employed if suitably modified for temperature control purposes.

Following the steam boiler the gases pass through the first converter where most of reaction (2) takes place and a gas temperature rise results. It is estimated that 70-80 percent of the sulfur recovered is formed in the first stage and the balance in the second after intermediate product removal. The catalyst employed is activated bauxite which has an indefinite life, being subject only to mechanical failure. The converters are carbon steel vessels lined with a suitable sulfur resistant cement.

In order to remove the sulfur formed in the converter the gases are cooled to approximately 300° F. and the sulfur condensed. A heat exchanger is employed to cool the gases entering the first scrubber and reheat them before entering the second converter. Final cooling and condensation take place in carbon steel, Raschig ring packed scrubbers where the hot gases pass countercurrent to liquid sulfur. The circulating sulfur, heated in the scrubbers, returns to the sulfur tank carrying with it the newly formed sulfur. The tail gases largely consist of nitrogen, water vapor, carbon dioxide (if present originally), and small percentages of unreacted H_2S and SO_2.

The concrete sulfur tank not only serves as a sump for the sulfur circulating and product pumps but also as surge storage space. The liquid sulfur to be recirculated over the scrubbers is first cooled with water, as shown, or by other means. The product sulfur may be pumped to vats for solid storage, to tank cars or trucks for shipment, or directly to a subsequent processing operation such as sulfuric acid plant. The pumps are vertical immersed-type centrifugal pumps especially designed for sulfur service. Liquid sulfur is held between 250° and 300° F. at all times to avoid the higher viscosity ranges above and below these temperatures, and piping is jacketed with 25 to 30-psig. steam to keep the sulfur in a free flowing state.



Production of Hydrocarbon Feed Stocks For Petrochemical Processes

M. VAN WINKLE
Associate Professor of Chemical Engineering, University of Texas, Austin

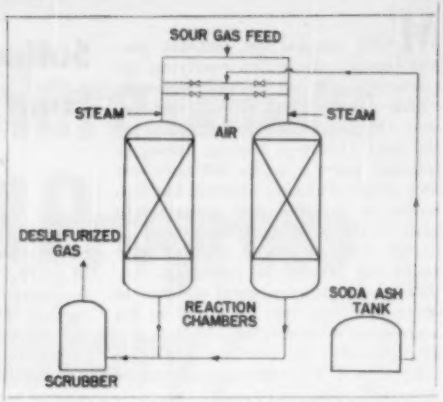


Figure 1. Iron Oxide Desulfurization

THE growth of the petrochemical industry in the past few years has been very rapid. In the period prior to 1940 production of byproduct chemicals from petroleum hydrocarbons, with the possible exception of methanol, was relatively small. The total production in 1925 amounted to less than 150,000 pounds, while in 1946 the total production of petrochemicals was 3.8 billion pounds.

Originally the petroleum companies entered the field of synthetic organic chemicals a) to insure supply of certain sales items to their customers, b) to obtain certain process chemicals needed as solvents or additives in petroleum products, or c) to dispose of normally waste byproducts which could not be disposed of by eliminating them into the air, water, or soil. Examples of the above are a) methanol for antifreeze; b) ethanol for solvent separation of petroleum sulfonates resulting from acid treatment of oil; phenols and cersols for antioxidants in gasolines and oils; and c) detergents, emulsants and demulsants from sulfuric acid sludge, sulfuric acid and sulfur from hydrogen sulfide and sulfur dioxide, acids and soaps from acid and basic treating wastes.

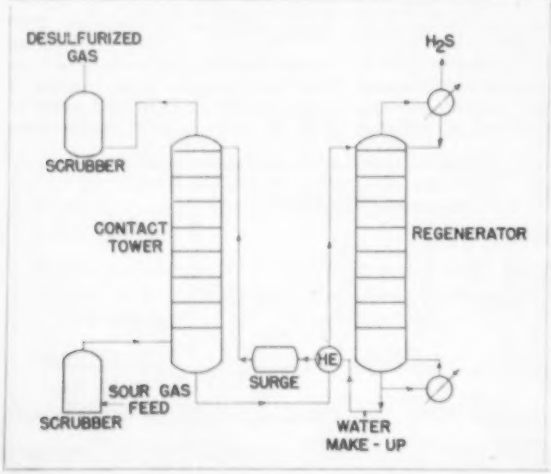
Research on methods of production of various valuable chemicals directly from hydrocarbons proved the economic feasibility of such processes. With the added impetus imparted by the wartime demands for peak production, the petrochemical industry was transformed from a byproduct industry, depending upon the economics of the petroleum industry, to an industry having its own markets and capable of existing and growing by itself.

Major Petrochemicals

Although all of the 5500 distinct products which are derived from petroleum and natural gas could be classed as petrochemicals, the generally accepted definition of the term "petrochemical" excludes all of the materials which are utilized strictly as fuels, lubricants, and supplementary products not definable by means of a chemical formula. The definition includes all of the chemicals which are derived directly from petroleum and natural gas which can be identified by chemical formulae.

Table 1 lists the principal petrochemicals from the standpoint of quantity, the primary hydrocarbon material or raw material associated directly with the crude oil or natural gas, the intermediate material serving as a feed to the petrochemical process.

Figure 2. Amine Desulfurization



PETROLEUM LIQUIDS AND GASES are supplanting to a considerable extent the use of coal tar as the principal source material for organic chemicals manufacture. The vastly expanded petroleum chemicals industry of the United States supplies about 40 percent of these organics. Since the volume of these chemicals account for only about 0.5 percent of the total crude oil and natural gas produced, it is small by oil industry standards. The high unit values of the products and low cost raw materials, however, have provided frequent opportunities for profitable commercial operation.

This article reports briefly the principal methods used for preparing hydrocarbon feed stocks for petrochemical process operations. For the most part, these processes are similar or identical to corresponding ones used in the refineries and natural gasoline plants in the manufacture of fuels, solvents, and other materials. This is to be expected since most petrochemical feed stocks are typical natural gasoline plant or refinery products—except possibly for separation to a higher degree of purity.

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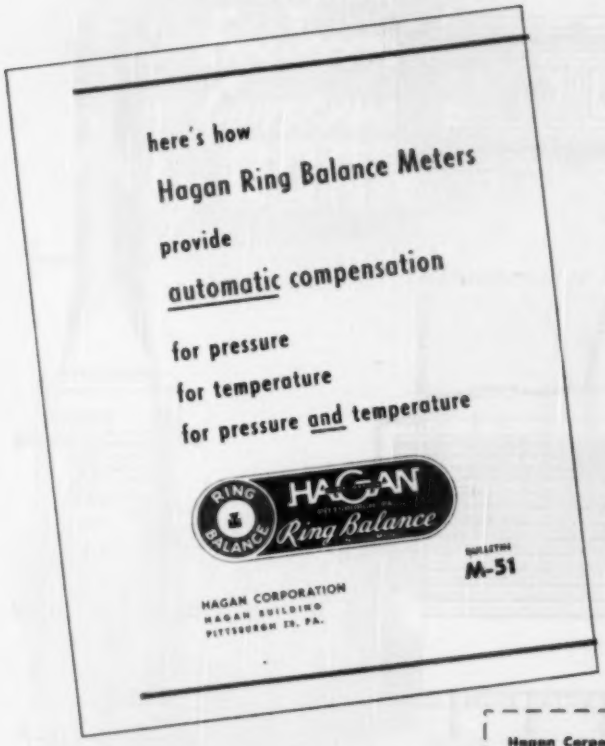

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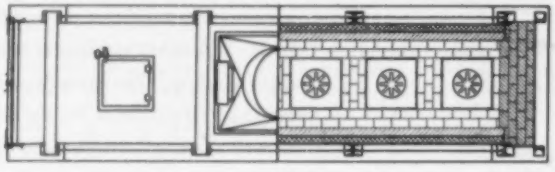
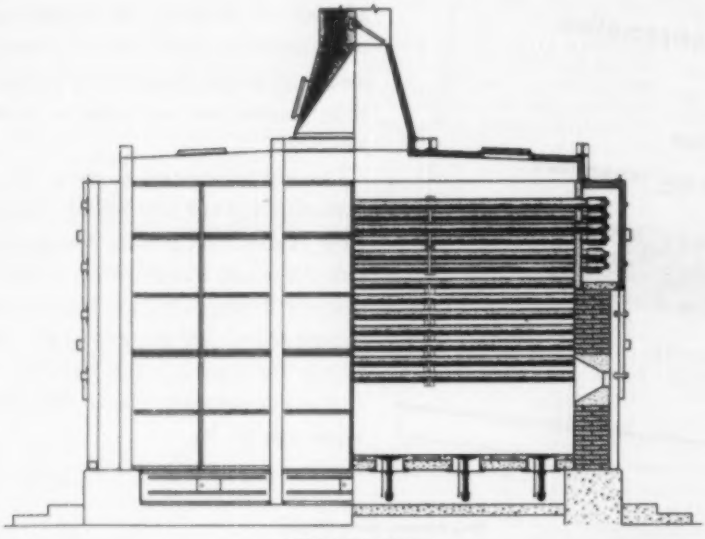
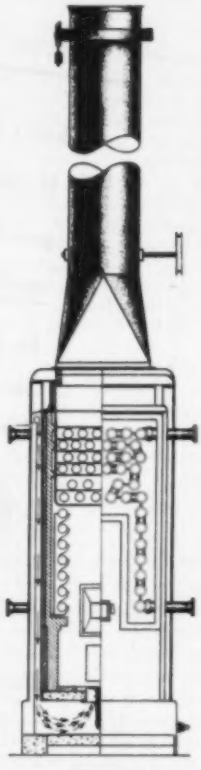


PLAN SECTION



SIDE ELEVATION SECTION



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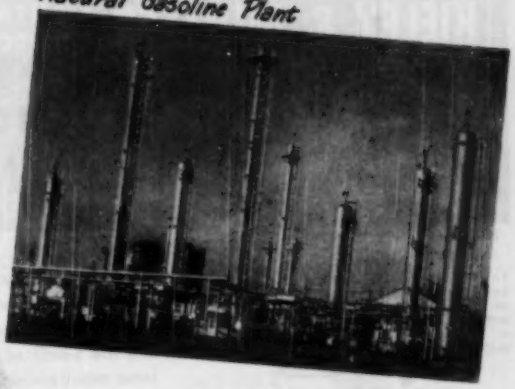

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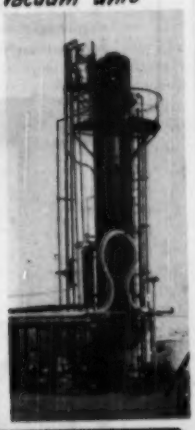

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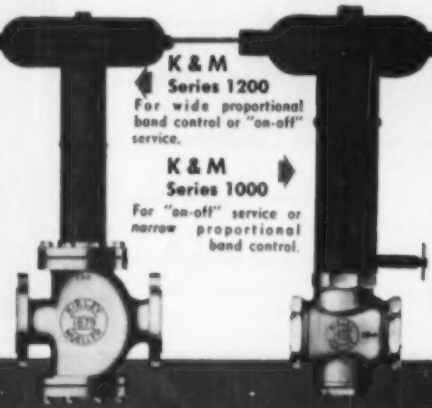

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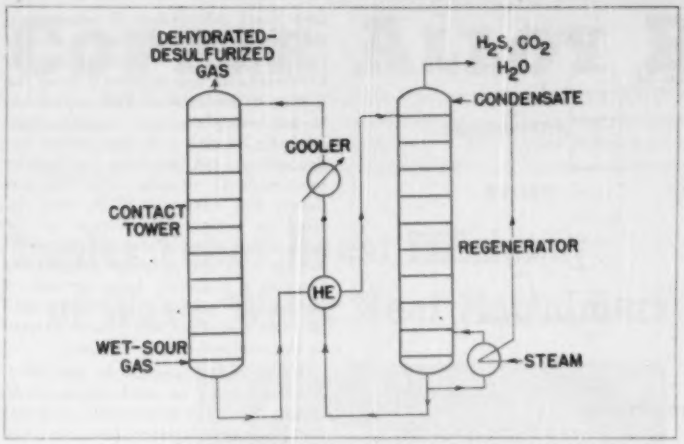

Figure 3. Combined Desulfurization and Dehydration

and the process required to convert the primary material to suitable feed stock for the chemical production processes.

Natural Sources of Primary Hydrocarbons

Typical composition ranges for natural gases and refinery gases are given in Table 2.

TABLE 2
Composition Ranges for Petroleum Gases[5, 6, 7]

Component	Natural Gas	Refinery Gas From Cracking and Stabilization	Natural Gasoline
CH_4	73.0-99.0	18-32	0-0.2
C_2H_6	4.1-23.8	8-35	4-6
C_2H_4		2- 4	
C_3H_8	2.6- 9.9	10-17	20-32
C_3H_6		6- 8	
C_4H_{10}	1.5- 6.8	3- 8	12-30
C_4H_8		1- 3	
C_5H_{12}	2.0-14.9	6-23	18-35
C_5H_{10}		4- 8	
C_5*	2.0- 6.0	1- 5	10-35
N_2	0 - 8.0	0- 1.0	
CO_2	0.0- 0.5		
H_2		4-30	
H_2S	0 - 7.0	2- 4	
He			
C_6H_6			

The above table indicates that natural gas and natural gasoline contain no olefinic materials while the refinery gas resulting from cracking processes contains appreciable percentages of olefins. Thus, with the exception of benzene, all of the primary hydrocarbon and associated components necessary for the production of petrochemicals are present in the sources listed. Benzene may be obtained from petroleum aromatization processes, destructive distillation of coal, or fractional distillation of aromatic base crude oils.

TABLE 1
Petrochemicals from Hydrocarbons[2, 4]

PRODUCT	Basic Hydrocarbon Raw Material	Intermediate Material	Conversion Process
Oxygenated Compounds			
Acids			
Formic	CH_4		Direct Catalytic Oxidation
	C_2H_6,C_3H_8	C_2H_4,C_3H_6	Tubular, Catalytic, or Regenerative Cracking
Acetic	C_2H_6,C_3H_8		Direct Catalytic Oxidation
	C_2H_6,C_3H_8	C_2H_4,C_3H_6	Tubular, Catalytic, or Regenerative Cracking
Alcohols			
Methyl	CH_4,C_2H_6,C_3H_8	H_2,CO	Steam Conversion or Direct Catalytic Oxidation
Ethyl	C_2H_6,C_3H_8	C_2H_4	Tubular, Catalytic, or Regenerative Cracking
Isopropyl	C_3H_{10}	C_3H_6	Tubular, Catalytic, or Regenerative Cracking
Butyl	C_3H_{12}	C_4H_8	Tubular, Catalytic, or Regenerative Cracking
Aldehydes			
Formaldehyde	CH_4, C_2H_6,C_3H_8		Steam Conversion or Direct Catalytic Oxidation
Acetaldehyde	C_2H_6,C_3H_8,CH_4	C_2H_2	Regenerative Cracking
			Schoch Electric Discharge Process
Ketone			
Acetone	C_2H_6,C_3H_8	C_3H_6	Tubular, Catalytic, or Regenerative Cracking
	C_4H_{10}	$C_{3}H_{6}$	Catalytic Oxidation
Resins			
Acrylic	C_3H_{10}	C_3H_4,C_4H_6	Tubular, Catalytic, or Regenerative Cracking
Vinyl	C_2H_6,C_3H_8	C_2H_2,C_2H_4	Regenerative Cracking
Halogenated Compounds			
Methyl Chloride	CH_4		Direct Chlorination
Methylene Chloride	CH_4		Direct Chlorination
Chloroform	CH_4		Direct Chlorination
Carbon Tetrachloride	CH_4		Direct Chlorination
Ethyl Chloride	C_2H_6	C_2H_5	Direct Chlorination
		C_2H_4	Dehydrogenation
Ethylene Chloride	C_2H_6	C_2H_4	Direct Chlorination
		C_2H_4	Dehydrogenation
Polychlorethanes	C_2H_6	C_2H_5	Direct Chlorination
		C_2H_4	Dehydrogenation;
Chloropropanes	C_3H_8	C_3H_7	Direct Chlorination
		C_3H_6	Dehydrogenation
Chlorobutanes	C_4H_{10}	C_4H_{10}	Direct Chlorination
		C_4H_8	Dehydrogenation
Nitrated Compounds			
Nitromethane	CH_4,C_3H_8,C_4H_{10}		Direct Nitration
Nitroethane	C_2H_6		Direct Nitration
Nitropropane	C_3H_8,C_4H_{10}		Direct Nitration
Nitrobutane	C_4H_{10}		Direct Nitration
Synthetic Rubber			
Butadiene	C_3H_8	C_3H_2	Regenerative Cracking
	C_4H_{10}	C_4H_8	Catalytic Dehydrogenation
	CH_4, Mixed Hydrocarbons	C_2H_2	Schoch Electric Discharge Process
Styrene	C_2H_6,C_6H_6	C_8H_8,C_2H_2	Alkylation, Dehydrogenation
Others			
Acetylene	CH_4		Schoch Electric Discharge Process
	C_2H_6, C_3H_8		Regenerative Cracking
Ammonia	CH_4,C_2H_6,C_3H_8,N_2		Dehydrogenation, Fractionation
Hydrogen	CH_4,C_2H_6,C_3H_8, C_6, H_6		Dehydrogenation
Helium	Natural Gas		Fractionation
Nitrogen	Natural Gas		Fractionation
Carbon Black	CH_4 and higher hydrocarbons		Schoch Electric Discharge Process or Cracking-Partial Oxidation
Sulfur	H_2S		Catalytic Conversion
Sulfuric Acid	H_2S	SO_2	Oxidation

Pre-treatment of Gas

The uses of natural gas and refinery gas as fuel, as a source of pure hydrocarbons for subsequent processing, or as a source of natural gasoline, require that the hydrogen sulfide be eliminated a) because of its corrosiveness, b) its catalyst poisoning characteristics and c) its objectionable odor. Thus the gas must be desulfurized before processing. In addition, hydrocarbon gases maintained under pressure in the presence of water, at the air and ground temperatures encountered in transmission through pipe lines, tend to form hydrates. Hydrates are solid "compounds" which involve an indefinite combination of water and hydrocarbons. These hydrates cause complete stoppage of pipe lines in many cases. Because of this danger, it is necessary to dehydrate the gas if it is to be handled under conditions where hydrate formation might occur.

Desulfurization

Desulfurization processes for natural and refinery gases involve contacting the gas with a chemically reactive solid or liquid solvent.

The commonly used solid contact process uses wood shavings impregnated with iron oxide. This method is applicable to gases containing small amounts of hydrogen sulfide, usually

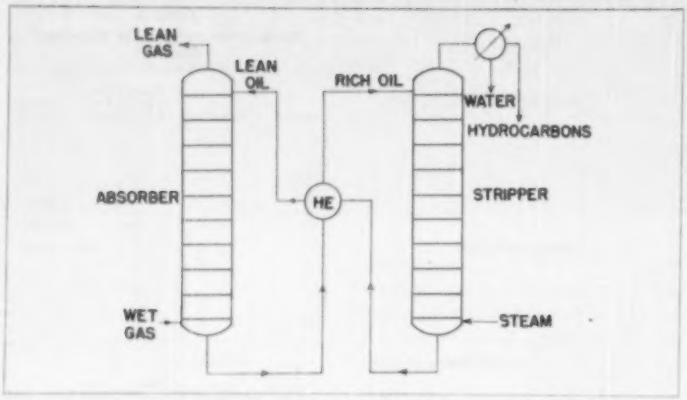

Figure 4. Absorption-Stripping.

not over 0.01 volume percent. Treating efficiencies of 87 percent of the theoretical (based on conversion of Fe_2O_3 to Fe_2S_3) have been experienced.[8] This process requires that the absorbant be alkaline and this condition is obtained by mixing sodium carbonate with the iron oxide.

The iron sulfide is regenerated to iron oxide by contact with air. The iron sulfide mass is either removed from the contact vessel and kept wet while standing in air to keep the temperature generated by the heat of oxidation from destroying the wood shavings or air is blown through the wet iron sulfide in the contact vessel.

Figure 1 schematically illustrates the flow.

The liquid solution processes have several advantages over the solid reactant processes in that they are continuous in operation, are generally regenerative, and will desulfurize gases containing large quantities of hydrogen sulfide. Table 3 lists the solvents commonly used for this purpose, and other pertinent information.

Figure 2 represents a typical schematic flow diagram for the processes described.

Dehydration [16, 17, 18, 19]

Removal of water from gas streams may be accomplished by the use of solid dessicants such as activated bauxite or alumina, or liquid dessicants such as ethylene glycol or diethylene glycol. The liquid dessicant usually is composed of 95-98 percent glycol with the remainder water. The process is regenerative in that the solution from the bottom of the dehydration tower is heated in a still and the water removed by distillation. The solution, reduced in water content, is then recycled. In some instances [17, 19] simultaneous removal of both hydrogen sulfide and water is obtained by passing the gas through a contact tower countercurrent to a solution essentially composed of 20 percent monoethylanine, 75 percent diethylene glycol, and 5 percent water. This solution is regenerated in a still and continuously recycled as shown in Figure 3.

TABLE 3

Desulfurization Solvents[7]

Solvent	Concentration in Water Solution	Temperature of Process °F.	Regeneration Temperature °F.
Monoethanolamine[10]	15–20	100–125	240–310
Diethanolamine[10]	20–25	100–125	240–310
Mixed Amines[10]		50–100	200–320
Sodium Phenolate[11, 13]	20–25	80–125	200–230
Tripotassium Phosphate[4]	35–50	100–200	200–250
Sodium Carbonate	10–30	80–125	200–230
Alkacid[2] (Aqueous solution of Amino Acids)	20–35	80–125	200–230

Primary Separation Methods for Light Hydrocarbons

Absorption

After the hydrocarbon gases (natural or refinery) have been desulfurized (and dehydrated if necessary), they are normally subjected to absorption processes in which the heavier hydrocarbons are separated from the lighter hydrocarbons. This separation is not complete and usually some methane remains with the heavier hydrocarbons and some of the heavier hydrocarbons remain with the methane. For example, if it were desired to remove 95 percent of the propane in a gas mixture, there would remain with the propane and heavier fraction a relatively large amount of methane and ethane. Also, there would be some isobutane and butane present in the methane-ethane mixture.

While the separation is not exact, it is necessary in most cases, a) to reduce the total quantity of material for subsequent fractionation into pure compounds, b) to increase the concentration of these in the feed to the fractionation system, and, c) to reduce the pressure on the fractionation system.

Figure 4 is a schematic diagram of a typical absorption-stripping operation. In this process the gas is fed into the bottom of a bubble cap or packed column wherein it passes countercurrently to a stream of absorber oil flowing down the column. The stripped or lean gas leaves the top of the column. The "lean" absorber oil enters the top of the column and leaves the bottom of the column as "rich" oil, i.e., containing absorbed hydrocarbons from the gas. The "rich" oil is pumped to the top of a stripping tower where it passes down the column countercurrent to steam which is admitted to the bottom of the stripping column. The oil, stripped of its absorbed hydrocarbons, is cooled by interchange with the rich oil in heat exchangers and fed to the absorber column. The hydrocarbons stripped

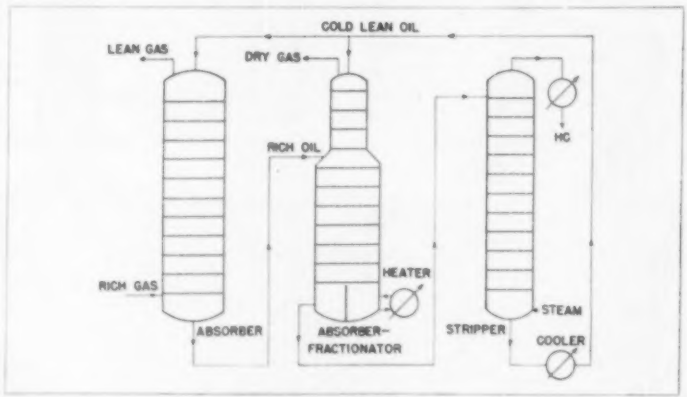

Figure 5. Fractionating-Absorption.

COPPER ALLOY BULLETIN

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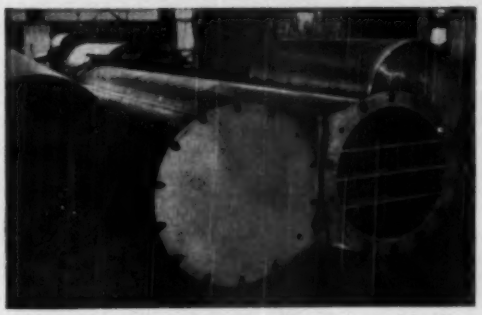
Prepared by Bridgeport Brass Company — "Bridgeport" — *Headquarters for BRASS, BRONZE, and COPPER*

Duplex Tubes Boost Efficiency of Waste Water Heat Reclaimers

Many valuable sources of heat have been overlooked for a long time. Now reclamation and reuse of heat which was normally wasted is spreading quite rapidly to industrial fields as an effective means of cutting costs. This practice, however, has been long used in power, petroleum and chemical processing operations.



Waste water heat reclaimer used at a bleachery is one of four in system designed to reduce fuel consumption and relieve over-loaded boilers—Courtesy Patterson Kelley Co., East Stroudsburg, Penna.

For example, Duplex Tubing (steel inside and copper outside) is playing an important part in the transfer of heat from waste water to fresh water used in mill bleaching processing.

Four waste-water heat reclaimers are utilized in system illustrated above designed to reduce fuel consumption and relieve over-loaded boilers. They are single-unit, closed-type, multi-pass construction on both tube and shell side.

High velocity waste water containing caustics passes through the tubes and soft fresh water at controlled velocity through the shell side.

RESULTS OF HEAT TRANSFER TESTS
DUPLEX VS. SINGLE WALL TUBING
Steam Condensed on Outside Surface With Fresh Water Passing Through The Tubes

Water Velocity Feet per Second	OVERALL HEAT TRANSFER RATE AT INDICATED WATER VELOCITY BTU/HR./SQ. FT./° F.	
	Duplex Tubing ¾" O.D. x Wall Thicknesses .0325" and .0325"	Regular Tubing ¾" O.D. x Wall Thickness .065"
2½	Steel to Steel 371	Steel 380
3½	458	458
2½	Copper to Copper 580	Copper 600
3½	750	740
2½	Steel to Copper 465	Steel 380
3½	625	458

1610 Gallons Heated Per Minute

The total overall heat recovery of the four units is theoretically set at approximately 4.5 million BTU's per hour. This is equivalent to approximately 47,000 lbs. of steam per hour at 100 lb. pressure which would ordinarily be used for heating the 1610 gallons of fresh water passing through the reclaimers per minute.

Steel-Copper Duplex Selected

Since the analysis of the waste water indicated a high caustic content, steel was selected for the inner section of the Duplex Tube. Copper was used to the fresh water side because the type of water involved would have attacked the steel quite rapidly. At the same time Duplex Tubing (copper-steel) increased the heat transfer characteristics of the units above what would have resulted with single-walled steel tube.

A better heat transfer rate of this Duplex Tubing also resulted in a more efficient unit as compared with a similar unit with single-walled steel tube.

Heat Transfer Tests

To test the heat transfer of the mechanical bond use the Bridgeport's Duplex Tubing, tubes of the same material were drawn together in the same manner as used for duplex. These Duplex-walled tubes were compared with single-walled tubes of the same dimension. The tests showed that the mechanical-bonded tubes gave identically the same heat transfer value as for single-walled tubes (see table).

Workmen making up tube bundle with Duplex Tubing (copper-steel) for waste water heat reclaimer—Courtesy Patterson-Kelley Co., East Stroudsburg, Penna.

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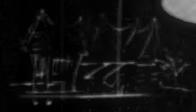
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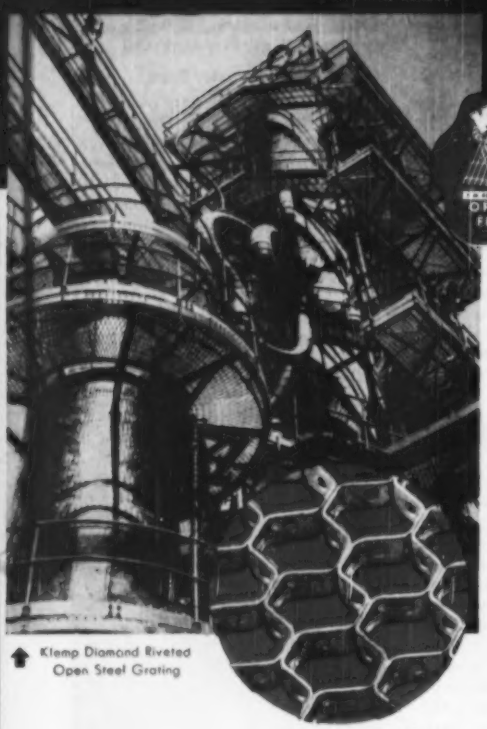

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out by the steam are separated by condensing the steam, and then are pumped to the fractionation system.

The absorption process may be operated at the pressure at which the rich gas is available, usually the case in natural gas absorption, or compressed to a higher pressure (refinery gas absorption).

The temperature of absorption is maintained as low as economically feasible a) to reduce the size of equipment, b) to increase the solubility of the hydrocarbons in the absorbant, and c) to prevent excessive operating pressures.

In the stripping operation the pressure is kept as low as possible and the temperature as high as possible to completely eliminate the absorbed hydrocarbons from the absorber oil.

At a given temperature and pressure the molecular weight of the absorber oil has a marked effect on the percentage recovery of a component.

TABLE 4
Composition of Absorber Feed and Products
Mole %

Component	Feed	Lean Gas	Absorbed Material
CH_4	89.33	93.67	34.72
C_2H_6	5.52	4.95	12.76
C_3H_8	2.46	1.34	16.70
nC_4H_{10}	0.59	0.04	7.47
C_4H_{10}	0.60	....	8.01
iC_5H_{12}	0.36	....	4.88
nC_5H_{12}	0.25	....	3.12
C_6*	0.91	....	12.34
	100.00	100.00	100.00

The lower the absorber oil molecular weight, the greater percentage recovery of a particular light hydrocarbon. Because of this effect, absorbants having molecular weights as low as 150 have been used to increase propane recovery.

Table 4 lists exemplary compositions for the feed, lean gas, and absorbed material in a typical absorption-stripping operation.

Absorption Fractionation [20, 21]

Because the conventional absorption processes absorb normally unwanted methane and ethane in addition to the propane and heavier hydrocarbons if reasonable recovery of the propane is obtained, a combination absorption fractionation process was designed to eliminate the methane and most of the ethane from the rich oil.

The process flow shown schematically in Figure 5 operates as follows: The main absorber operates normally. The rich oil from the main absorber is charged to the middle of the absorber-fractionater column. Cool lean oil is admitted to the top of the absorber section and it absorbs the lighter components vaporized from the rich oil in the reboiler section. The lean oil containing the light components acts as reflux to the reboiling section. As the result of this arrangement, the rich oil emerging from the reboiling section has the lighter components, methane and ethane, fractionated from it and contains essentially all of the desired propane and heavier hydrocarbons. This rich oil can be charged to a fractionater to separate the hydrocarbons from the lean oil.

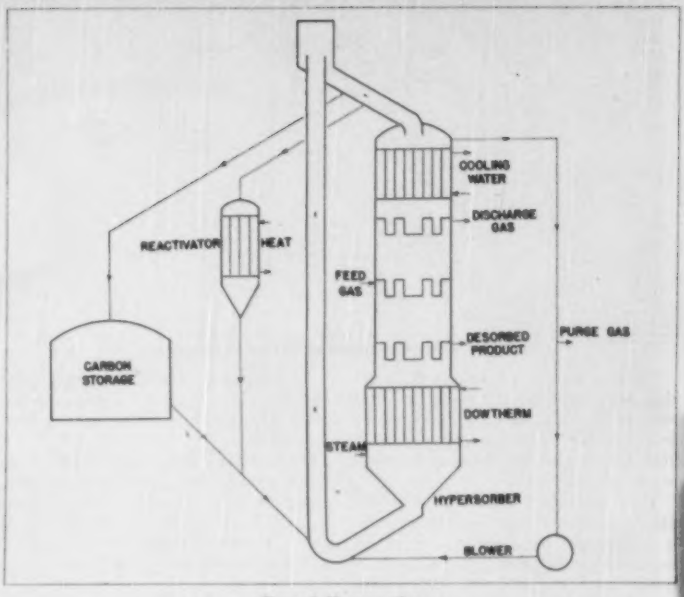


Figure 6. Hypersorption

Hypersorption [22, 23, 24]

The hypersorption process was developed as the result of the observation that the higher boiling materials were adsorbed in the gaseous state preferentially on activated charcoal. Where it is desired to separate two materials, one having a higher boiling point than the other, it is possible to obtain very high recoveries of the adsorbed component. In most cases it is necessary that the component to be absorbed be present in much smaller quantity than the other component to make the process economically feasible.

The schematic flow diagram for the hypersorption process is shown in Figure 6.

The flow is as follows: The feed gas is introduced to the center of the column where it contacts the finely divided carbon moving down the column. The adsorbed material plus carbon pass down into the heated section, separated from the absorption section by gas traps, where the adsorbed material is desorbed from the carbon by heat and steam. The gas is conducted from the column to a cooler-dehydrator where the gas is dehydrated.

The unadsorbed gas passes upward in the adsorbing section and is removed from the column. The charcoal from the heating or regenerating section is carried to the top or cooling section of the hypersorber by gas lift obtained by means of a blower and part of the unadsorbed gas. Part of the carbon is continually subjected to heat and steam reactivation in an external reactivator to keep the over-all average adsorption efficiency of the carbon relatively high. The temperatures and pressures of operation vary with the components and completeness of separation desired.

Secondary Separation Methods

Fractionation

The hydrocarbon mixtures containing the components desired as final pure materials are next processed by fractionation. It is a general rule that for the separation of n components n-1 fractionating columns are necessary. Therefore, if a charge material contains propane, isobutane, butane, and pentanes and heavier hydrocarbons, and it is desired to produce relatively pure propane, isobutane, and butane, three columns are needed. (In this case the final bottoms, pentanes + is considered as one component.)

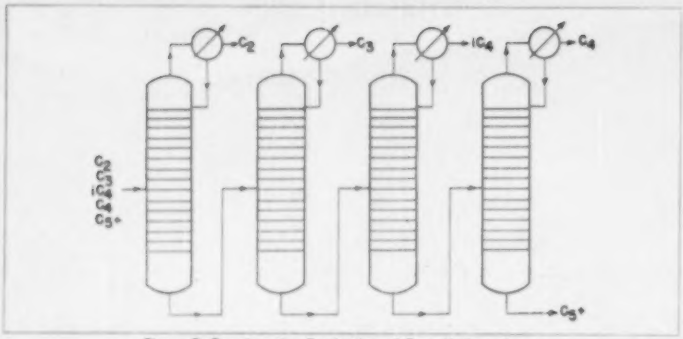


Figure 7. Fractionation-Production of Pure Hydrocarbons.

These columns are operated in series, normally the flow from one column to the next will be arranged so that the first column operates at a higher pressure, the next at a lower pressure, and so on.

Thus in Figure 7 the fractionators are so arranged that the first column is a depropanizing column. That is, the distillate from the depropanizer is relatively pure propane. Since propane has a higher vapor pressure than the remaining components, the depropanizing column will operate at a higher pressure than the others, assuming the same coolant (cooling water usually) is used in all condensers. The bottoms from the depropanizer containing isobutane, butane, and pentanes plus, are charged to the next column—the deisobutanizer, where isobutane is removed overhead and butane and heavier hydrocarbons removed from the bottom. The bottoms are charged to the debutanizer, where the butane is removed as distillate and the residue is recovered as bottoms product.

Low Temperature Fractionation

Because of the increase in relative volatilities of the light hydrocarbons as temperature decreases ($K_{C_4}/K_{C_5} = 6.5$ at 100° F. and 100 psia., and $K_{C_4}/K_{C_5} = 8.7$ at 40° F. and 100 psia.), there are fractionating columns being designed and built to operate at temperatures approaching—100° F. This operation is feasible for the demethanization of hydrocarbon mixtures where high ethane recovery is desired and where the increase in recovery of ethane offsets the cost of refrigeration.

Conversion Processes

The conversion processes of interest to the petrochemical industry for the production of petrochemical process feed stocks are those which produce acetylene, olefins, and diolefins. The process mainly used for this purpose are

1) Cracking—thermal, regenerative, and catalytic. Produces olefins, diolefins, and acetylene from heavier hydrocarbons.

2) Catalytic Dehydrogenation. Produces olefins and diolefins from the corresponding paraffin hydrocarbon.

3) Schoch Electric Discharge Process.[1, 2] Produces acetylene from methane and heavier hydrocarbons.

Cracking

Thermal or Tubular Cracking

Thermal cracking processes produce lighter hydrocarbons from heavier hydrocarbons, usually gas oils, by heating the charge materials above the temperature at which they are thermally stable. These processes usually operate at elevated pressures, 200-600 psia., and temperatures from 900-1050° F. The products formed are gases containing hydrogen, methane, olefins, iso- and normal paraffins, gasolines, heavier oils, and carbon.

The gas from the cracking process is processed by the methods discussed above for recovery of the particular hydrocarbons desired.

A typical thermal cracking schematic flow diagram is shown in Figure 8.

High Temperature Thermal Cracking[25]

Because of the value of ethylene as a feed stock for petrochemical processes, a high temperature cracking process has been developed wherein propane-ethane mixtures are charged to a cracking furnace at a temperature of 1400-1500° F. and at approximately atmospheric pressure with a residence time of approximately 2 seconds. With a charging stock of 70 percent propane, 20 percent ethane and 10 percent methane, it is claimed that a single pass yield of 30 pounds of ethylene per 100 pounds of feed can be obtained.

Catalytic Cracking

Catalytic cracking produces the same type of products as those obtained from thermal cracking at lower pressures (10-30 psia.) in the presence of natural or synthetic clay catalysts. The compositions of the products from catalytic cracking differ from those from thermal cracking because of the relative quantities of the various compounds produced.

Catalytic cracking processes are in use at present as follows: a) Houdry (fixed bed), b) Houdriflow (moving bed), c) Thermofor, d) Fluid and e) Suspensoid.

Table 5 shows a comparison of compositions of gases from the two types of process.

Regenerative Cracking[26]

Regenerative cracking has been used to some extent for the production of olefins and acetylene in this country and to a great extent in Europe. The regenerative furnace, utilizing checkerwork built from high temperature refractories, operates in cycles of

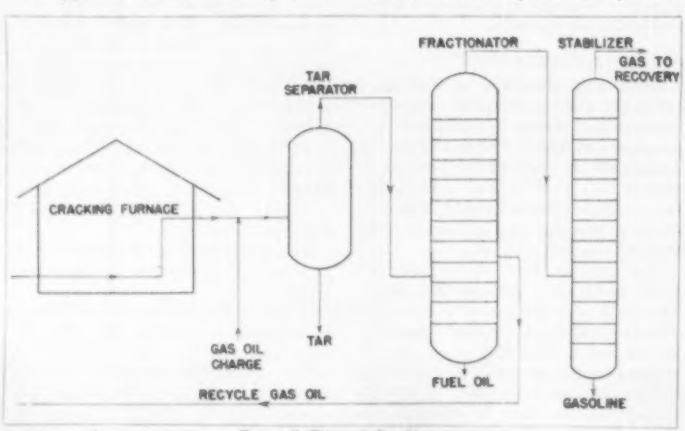
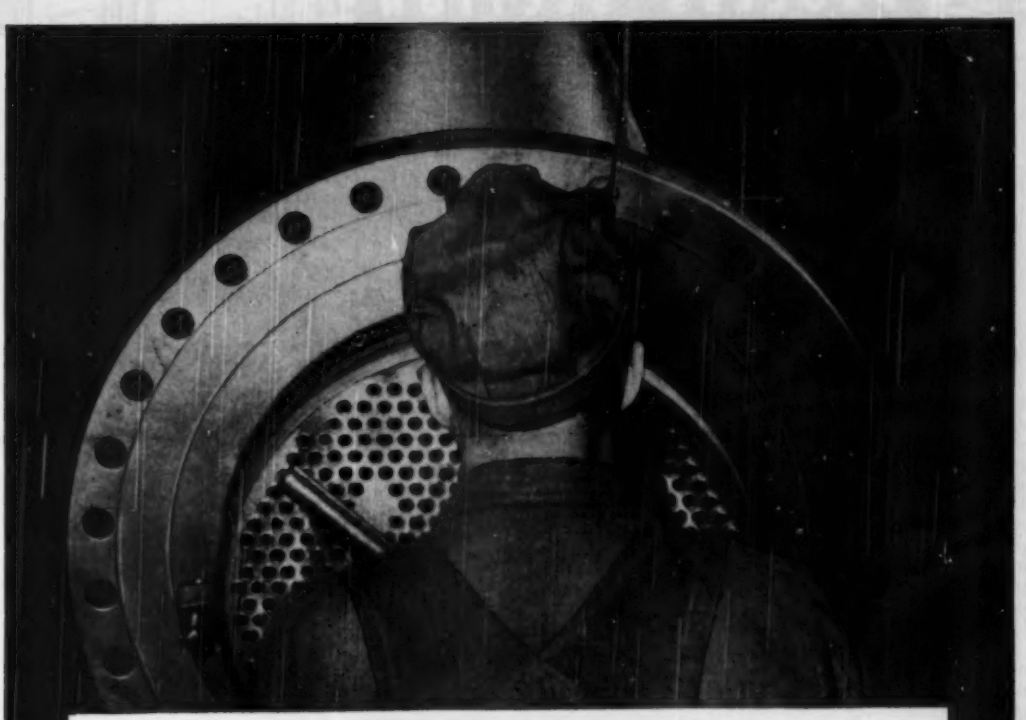


Figure 8. Thermal Cracking.



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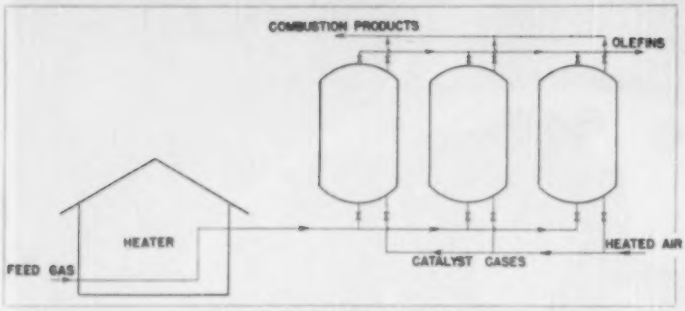


Figure 9. Catalytic Dehydrogenation

heating, cracking, and purging. The charge materials, methane, ethane, propane, butane, and sometimes heavier hydrocarbons are cracked at temperatures ranging from 1000 to 2500° F. The higher temperatures are necessary for acetylene production. For olefin production the yields of desired hydrocarbon are very low. Therefore the process is not used as much as dehydrogenation.

Catalytic Dehydrogenation [27, 28, 29, 30]

During the last war demand for increased quantities of olefins for the production of isooctane and aviation gasoline was responsible for development of catalytic dehydrogenation processes. These processes increased the yield of olefins from the same charge stock.

The catalyst used in catalytic dehydrogenation is chromium oxide deposited on alumina [27, 28, 29]. Process temperatures range from 450° to 750° C., and the pressure is approximately 1 atmosphere. The yields are reported to be 85 to 95 percent of the theoretical yield of olefins from paraffins. This represents actual product compositions of 50 to 55 percent butylene from butane, 30 to 35 percent propylene from propane, and 16 to 20 percent ethylene from ethane in single pass operation. Equilibrium characteristics of the systems at the necessary operating temperatures limit the yields to a value less than the theoretical. Styrene yield from ethyl benzene at 1000 to 1050° F. amounts to 40 to 45 percent. Butadiene produced from 50-50 butane-butene charge ranges from 12 to 14 weight percent.

The process utilizes a fixed bed catalyst involving two or more catalyst cases operating intermittently on dehydrogenation—eight minutes, purging—three minutes, and catalyst regeneration—eight minutes. The catalyst is regenerated by blowing air through the catalyst bed to burn off the carbon formed.

Figure 9 is a schematic flow diagram of the process.

TABLE 5

Composition of Cracked Gases[1]

	Catalytic	Thermal
H_2	20.6	4.7
CH_4	18.0	32.7
C_2H_6	8.0	27.6
C_2H_4	4.0	2.0
C_3H_8	15.0	12.2
C_3H_6	8.0	7.4
iC_4H_{10}	7.5	2.0
nC_4H_{10}	1.7	1.8
C_4H_8	3.0	4.4
C_4H_6	5.2	3.7
C_5^+	—	2.5

Other Processes

Sulfur From Hydrogen Sulfide [31, 32]

Several plants have been designed and erected to produce pure sulfur from the hydrogen sulfide extracted from petroleum gases. The process operates as follows: The monoethanolamine or diethanolamine solution from the gas desulfurization plant is stripped of its H_2S content in a stripper. The H_2S gas is heated in a gas-fired preheater and passed to a catalytic reactor. Air is also preheated in another gas-fired preheater and mixed with the hydrogen sulfide at the entrance to the reactor. The conversion takes place at 700-750° F. with a yield of 92 to 94 percent of sulfur based on H_2S charged. Yields of 99 percent may be obtained by operating two reactors in series.

The reactions are as follows:

$$H_2S + 1\tfrac{1}{2}\ O_2 \rightarrow SO_2 + H_2O$$
$$SO_2 + 2\ H_2S \rightarrow 3S + 2\ H_2O$$

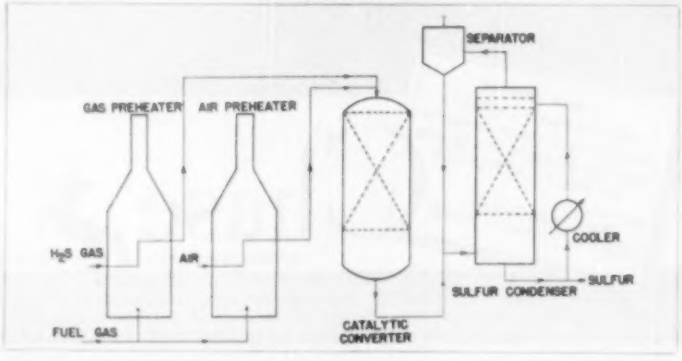
The catalysts are solid bed aluminum oxide, bauxite, pumice, porous iron oxide, and silica gel. The most common catalyst is natural bauxite containing 10 to 15 percent iron oxide. Space velocities range up to 100.

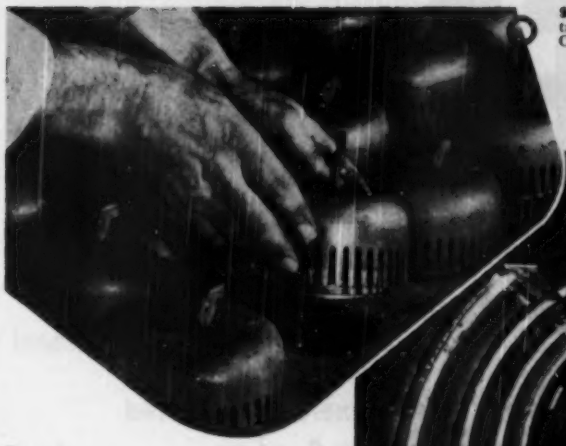
See Figure 10 for flow diagram.

BIBLIOGRAPHY

[1] Schoch, E. P., Oil Gas J., March 10, 1945, p. 62.
[2] Schoch, E. P., Acetylene From Hydrocarbons, Bureau of Industrial Chemistry, The University of Texas, Publication No. 5011, June 1, 1950.
[3] Pew, J. E., and Dotterweich, F. H., Petroleum Refiner, **23**, No. 4, 96 (1944).
[4] Smith, H. M., and Holliman, W. C., Petroleum Refiner, **26**, No. 4, 75 (1947).
[5] Nelson, W. L., Petroleum Refinery Engineering, McGraw-Hill Book Company, IIIrd Edition (1949).
[6] Schnidman, L., Gaseous Fuels, American Gas Association (1948).
[7] Egloff, G., Oil Gas J., August 30, 1947, p. 88.
[8] Connors, J. S., and Miller, A. J., Oil Gas J., Feb. 2, 1950, p. 57.
[9] Reed, R. M., Oil Gas J., March 30, 1946, p. 219.
[10] Connors and Miller, Oil Gas J., Feb. 2, 1950, p. 57.
[11] Anon., Petroleum Refiner, **16**, No. 2, 92 (1937).
[12] Raehr, H., Petroleum Refiner, **17**, No. 6, 237 (1938).
[13] Garvlin, G. M., Petroleum Refiner, **17**, No. 6, 225 (1938).
[14] Coulthurst, L. J. and Croix, H. N., Petroleum Refiner, **18**, No. 8, 99, (1939).
[15] Wood, W. R. and Storrs, B. D., Petroleum Refiner, **17**, No. 6, 234 (1938).
[16] Buchan, *et al.*, Oil Gas J., April 6, 1950, p. 74.
[17] Rieesenfeld and Cody, Petroleum Engineer, Jan. 1950, p. C 21.
[18] Barrow, D. N., Petroleum Refiner, **27**, No. 12, 105 (1948).
[19] Russell, *et al.*, Petroleum Refiner, **24**, No. 12, 127 (1945).
[20] Hannah, J. C., Petroleum Refiner, **28**, No. 8, 1925 (1949).
[21] Whistler, A. M., Petroleum Refiner, **25**, No. 2, 135 (1946).
[22] Berg, C. Transactions AIChE, **42**, 665 (1946).
[23] Bland, W. F., Petroleum Processing, July, 1948, p. 635.
[24] Berg, *et al.*, Oil Gas J., April 28, 1949, p. 95.
[25] Buell, C. K., and Weber, L. J., Petroleum Processing, March, 1950, p. 266.
[26] Sherwood, P. J., Petroleum Refiner, **27**, No. 11, 93 (1948).
[27] Burgin, Groll, and Roberts, Petroleum Refiner, **17**, No. 10, 495 (1938).
[28] Grosse, *et al.*, Petroleum Refiner, **18**, No. 11, 100 (1939).
[29] Reisz, *et al.*, Oil Gas J., July 15, 1944, p. 67.
[30] Lassiat and Parker, Oil Gas J., Nov. 18, 1944, p. 229.
[31] Graff, R. A., Oil Gas J., Feb. 17, 1949, p. 99.
[32] Anon., Oil and Gas J., April 21, 1949, p. 241.

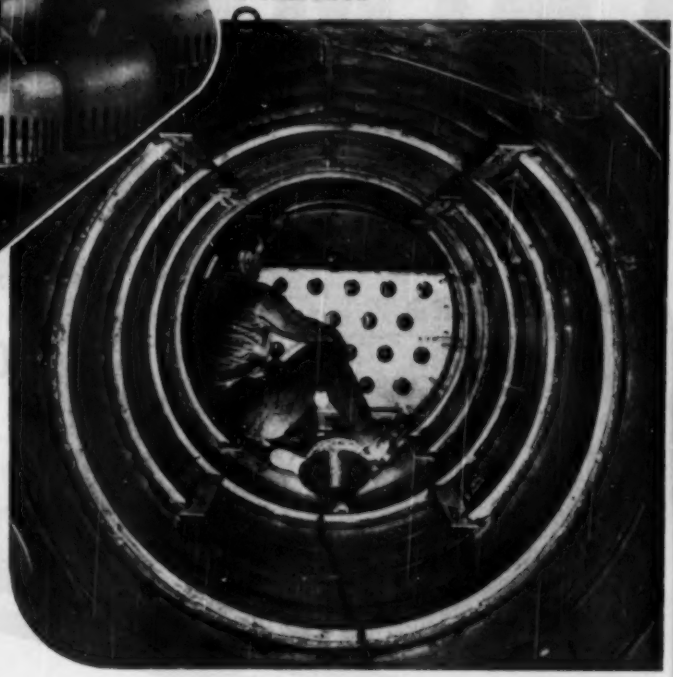
Figure 10. Sulfur from H_2S





Stainless Steel bubble caps being installed on a Stainless tray. The manufacturer is C. F. Braun and Co., Alhambra, Calif. (Patents Pending)

Workman installing removable Stainless Steel trays in a crude stabilizer. This equipment, too, was fabricated by C. F. Braun and Co.



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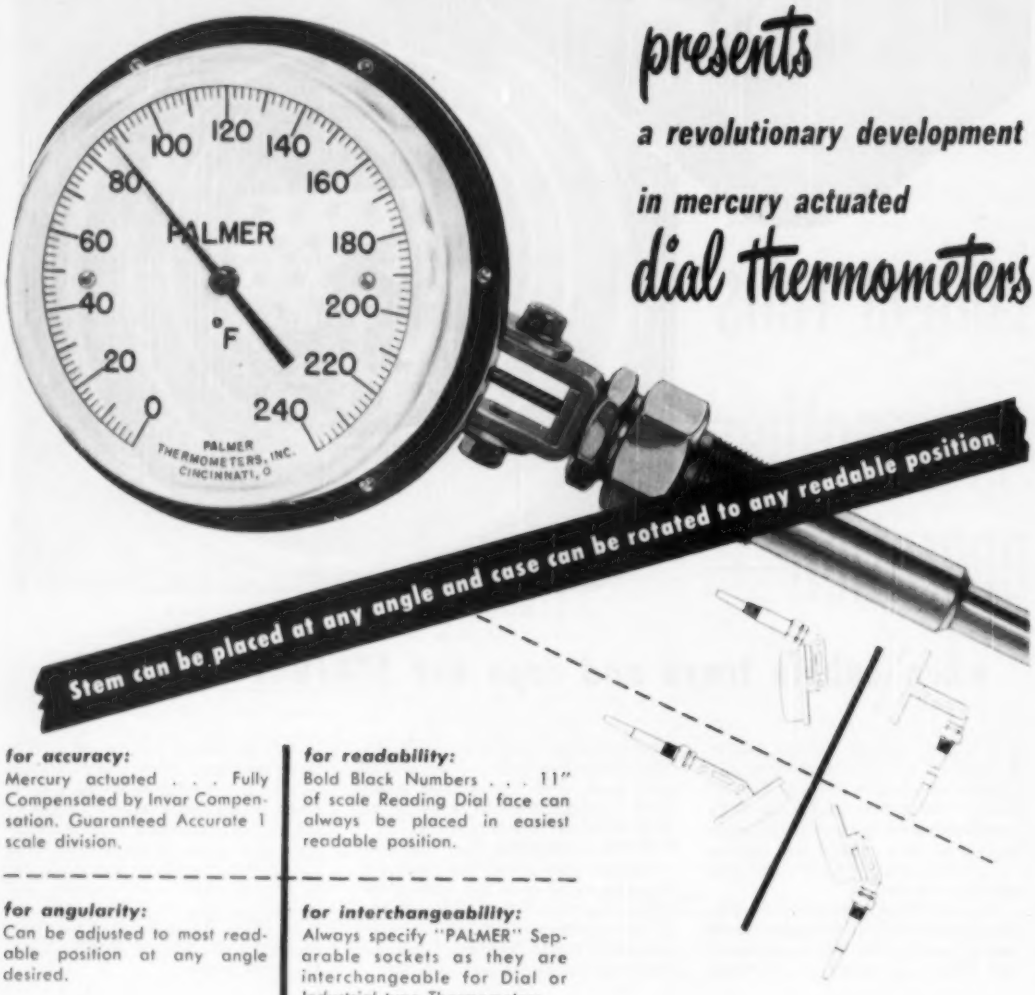
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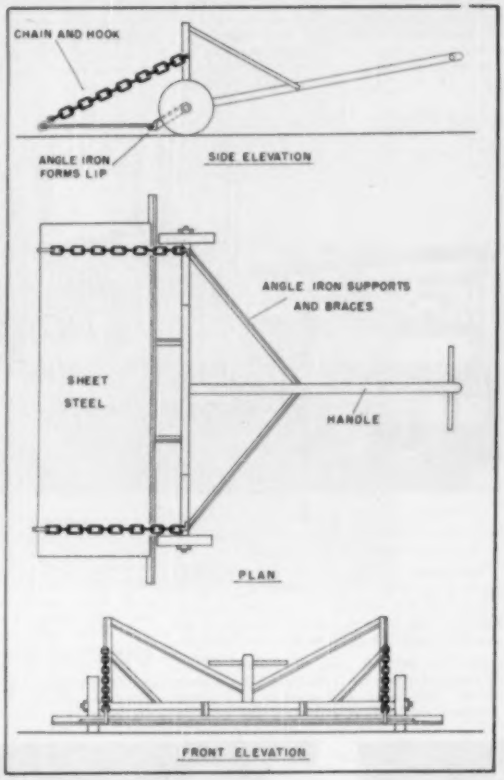
HOW TO DO IT

HOW—Roof Buggy Aids Tank Repair Crew

HANDLING sheet steel in construction and repairing of refinery storage tanks is a difficult job that often requires use of much heavy equipment and the erection of hoists and winches. One piece of equipment currently in use is designed to simplify moving steel plate into position on tank roofs. The buggy is illustrated in the drawing. After the sheets have been lifted to the roof of the tank, they are picked up with the buggy and moved to the location where they are needed.



The buggy consists of two wheels and two vertical angle iron posts, to which the handle and supporting frame are connected. The axle supports a lip section of angle iron parallel with the axle a few inches from the roof. One side of the sheet of steel being moved rides on the lip, and the other side of the sheet is lifted by hooks on the chains connected to the frame. When the sheet has been loaded on the buggy, downward pressure on the handle lifts the sheet clear of the roof and the buggy is pulled or pushed to the desired location.

Sketch and material courtesy of "Coin Your Ideas" Committee, Esso Standard Oil Company, Louisiana Division, Baton Rouge. Suggestion submitted by Ivy J. Clement, welder, boilermakers' department.

HOW TO—

Support Fire Hose Case

THE foundation supporting the small steel case, which houses fire hose and spray nozzles in a refinery, is built with the supporting column off-center. This method places the angle-iron support away from the roadway, yet leaves sufficient space to allow the housing to be swung right or left for use.

Four short legs are welded to the rectangular frame of angle iron which is set on a concrete pier. Footing for the supporting legs is made by welding flat pads to the lower ends, which then are bolted to the concrete pier. Gusset plates are welded to the frame so a short riser can be placed near one corner where the supply line enters carrying steam or water.

A swivel joint is provided so the building can be swung through an arc, with a similar swivel in the supply line for connecting the hose. Thus, the hose can be used, when the case is turned in any direction throughout a half-circle, without damage to the hose or the doors of the housing.

HOW TO PREVENT—

Storage Tank Corrosion

IN THE storage of crude oil, a tank maintenance problem occurs because of impurities present in the unrefined oil. These impurities include water and sulphur products which settle to the bottoms and lower sides of the tanks and cause corrosion.

The corrosive action is so severe that in time it becomes necessary to replace the tank bottom.

A new method to prevent corrosion in storage tanks contaming crude petroleum has been developed by the Industrial Service Company, Cushing, Okla., using a glass fiber pipe wrap material and coal tar blend enamel. A savings of $1500 per tank, plus the cost of 50 tons of steel, is possible, according to the company.

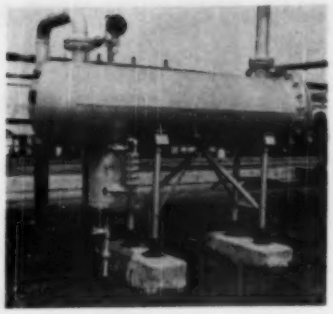
Industrial Service Company's method employs about 120 squares of glass fiber material per tank and 12 to 13 tons of coal tar blend enamel. The firm has treated about 60 tanks for Shell Oil Company by this method in the past

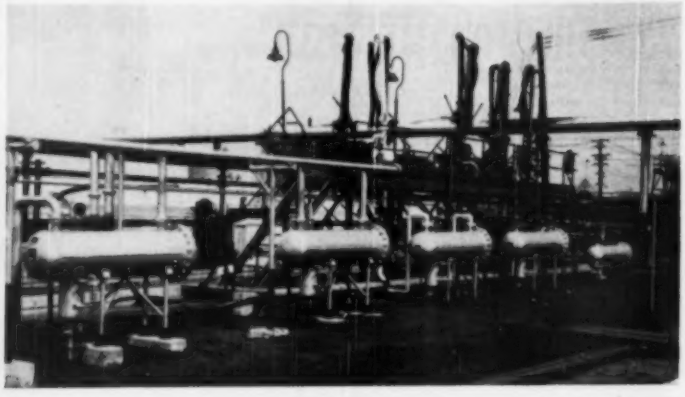
HOW TO MAKE—

Filter Tank Supports

GASOLINE filters in the tank loading area of this plant have been mounted on pipe supports rather than on conventional massive concrete piers. This low cost method of mounting permits adequate circulation of air for dissipation of any vapors which might accumulate in a more restricted area. Also, the area around this type of support is easy to clean and tends to promote improved plant housekeeping.

Foundations for the pipe supports are concrete piers with the top of each footing only slightly above ground. Triangular pads are welded on the shells of the filter cases and two-inch pipe collars attached into which the top of the pipe supports are inserted. Lower ends of the legs are welded to floor flanges bolted to the foundation. Angle iron cross members bolted between each pair of legs serve as diagonal braces. The apex of each brace is bolted to a plate welded to the underside of the filter case.





year. The procedure consists of nine steps:

1) The tank bottom and sides, 36 inches up from the bottom, are scraped and steel-brushed to remove scale and rust. Thirty-six inches represents the average depth of the bottom settlings and water that cause corrosion.

2) The tank bottom and sides, to the basic sediment line, are sand blasted.

3) The tank is cleaned of sand and

inspected for holes.

4) Any holes found are patched by welding a plate over them.

5) The first 3/16-inch coat of enamel blend is poured, using roofers' pouring buckets, and spread with a 36-inch wide push broom. The entire surface of the bottom of the tank is covered with the enamel, which is allowed to set.

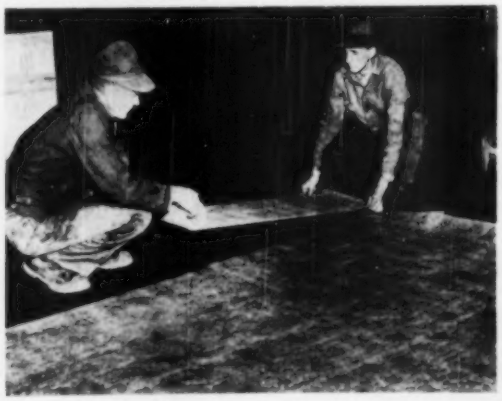
6) Starting opposite the entrance, 18-inch wide rolls of glass fiber material is placed on the surface of the first coat of enamel and lapped two inches until an approximate six-foot width is obtained.

7) The second coat of enamel blend is applied over the glass mat 3/16-inch thick. This coat is poured in the same manner as the first coat and the heat of the tar is great enough to soften the under coat so that the two coats blend into one solid mass rather than forming two laminations.

8) This operation is continued until the entire bottom surface is covered.

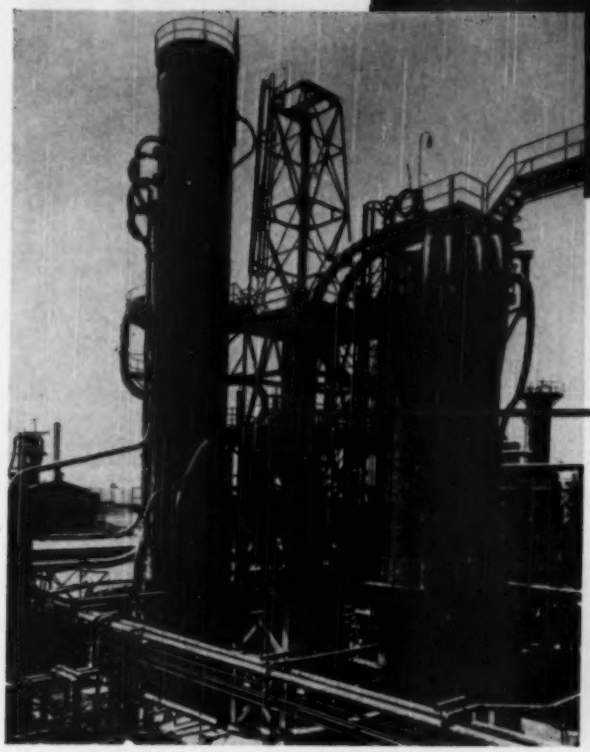
9) The walls are coated with enamel by means of the brush. No reinforcing is applied to the sides.

Photographs and material courtesy of Owens-Corning Fiberglas Corporation, 16 East 56th Street, New York.



TRET·O·LITE

DESALTING



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HOW TO STORE—

Refinery Maintenance Supplies

Heat arrangement of supplies in Conoco's Glenrock, Wyo., Warehouse.

PIPE fittings, valves, paint, electrical materials used each day in refinery maintenance are shown neatly arranged on the shelves and racks of this warehouse at the Glenrock, Wyo., refinery of Continental Oil Company. Materials are arranged for accessibility. Warehousemen have no difficulty in seeing the quantity of any particular item on hand, which aids in maintaining an adequate stock.

The valve storage rack in the background is unique. Large valves are stored on the bottom shelf. Smaller valves are hung by their handwheels on special racks. The racks consist of two long horizontal rods with pairs of short rods welded across them at intervals. These cross-rods are spaced to admit the stem of the valve, providing a fork support. Each pair of cross rods will accommodate several valves. The smaller valves are placed in the top racks.

In this portion of the warehouse, photo at left, are tool and material issue "horseshoes," tool checkboard, oil dispensing drums, electric wire racks, valves, and racks for storage of oxygen and acetylene cylinders.

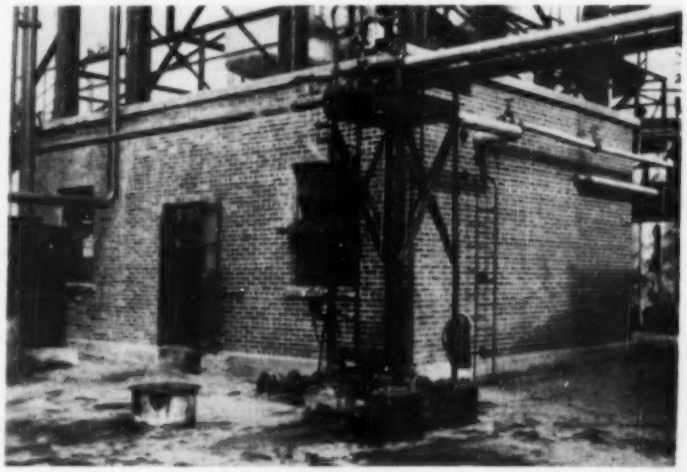
HOW SANDBLASTING—

Removes Foam Powder

IN extinguishing a small fire in a vacuum unit, a large amount of foam was used with the result that the red brick building (see photograph) was covered on three sides with foam powder. Efforts to remove this powder using wire brushes, acids and alkalies did not prove successful. The suggestion was made that sandblasting should be tried.

When normal sharp sand was used, the powder was removed but the face of the brick and the mortar was badly eroded. Local sand, however, which was considerably softer and more rounded was obtained and used with excellent results. The powder was removed and the building regained almost its former appearance. It was agreed previously, that painting a brick building was not desirable if it could be avoided. The cost of sandblasting was considerably less than for a paint job.

It has been suggested that sandblasting with various types sand might be used in removing stains, other than foam, from brick and other construction materials.



Utilizing Ni-Resist, these valves offer good resistance against sulphuric acid, hydrogen sulphide, sea water, brine solutions and alkalies. This type of Ni-Resist is also used in sewage disposal plants.

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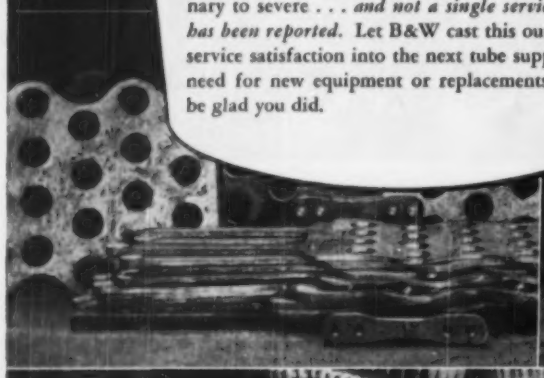

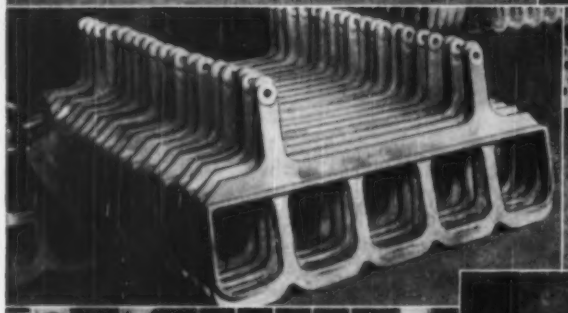

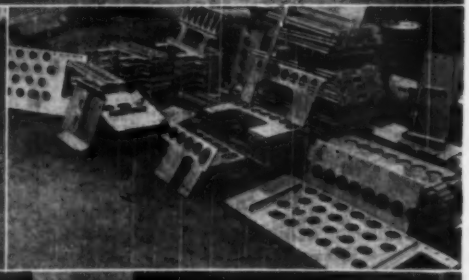

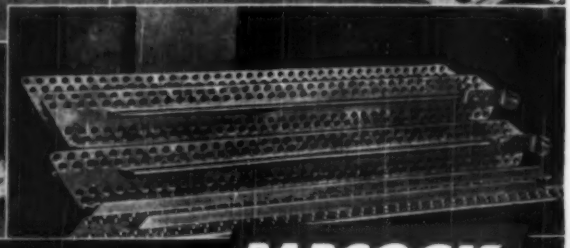

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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

Manufacture: Processes and Plant

Thermal Design of Condensers. WALTER GLOVER. *Ind. Eng. Chem.*, **42** (1950), pp. 1361-9.

The purpose of the author was the development of a rating method for condensers in commercial practice. The method presented has been in use in simple form since 1937 and has been expanded and improved since that time. It is based on well known principles of heat transfer by convection and conduction and is applicable to all kinds of surface condensers, although the present paper is limited to the consideration of shell and tube condensers. Heat release curves are given for the condensing vapor and increasing weight of condensate as condensation progresses. This heat release versus temperature relationship gives curves of parabolic shape, resulting in an improved mean temperature difference for the vapor and a reduced mean temperature difference for the condensate. Heat transfer by convection of vapors and the effect on condensation is analyzed. A relationship is presented to approximate a correction factor for this coefficient of heat transfer. A method for combining the heat transfer coefficient is presented. The problem of pressure drop is considered, including derivations for the average amount of vapor flowing through a condenser and the relative cross-sectional flow area for condensate and for vapor. A bibliography of 23 references is included.

Heat Transfer in Packed Beds—Analytical Solution and Design Method—Fluid Flow, Solids Flow, Chemical Reaction. E. SINGER and R. H. WILHELM. *Chem. Eng. Progress*, **46** (1950), pp. 343-57.

The authors discuss the transfer of heat in beds of packed solids with heat flowing through the wall of the container into the fluid flowing through the packed bed. An analytical treatment of the subject is presented as well as design procedure based thereon. Four mechanisms contribute to heat flow, including the convective transport of heat by net flow of the fluid, conduction of heat through the solid particles, heat flow between fluid and particles through a film resistance and conduction of heat through the fluid phase. Differential equations for the processes are set up and solved for cylindrical beds. Point solutions for solids and fluid temperature are given and solutions are given as well in terms of mixed terminal fluid temperatures. Equations were given for fixed bed heat exchangers, moving bed heat exchangers, and fixed bed chemical reactors. Typical problems are presented and their solutions are given.

Method and Chart for Number of Transfer Units in Diffusional Operations. G. EDWIN WHITE. *Chem. Eng. Progress*, **46** (1950), pp. 363-8.

A chart is presented for the rapid solution of design problems in diffusional operations. Numerical values of mean effective driving force can be obtained when given only the terminal driving forces and the central driving force. The latter can be replaced by a driving force located at a selected critical point. Certain logarithmic correction terms are required to obtain the mean effective driving force and to obtain the number of transfer units from the mean effective driving force. A nomograph is presented to facilitate this step. The equilibrium curve is presumed to be the arc of a parabola, and the operating line is assumed to be straight. The chart can, however, be extended to cases in which the operating line is curved.

Theoretical Analysis of Fractionating Process of Adsorption. BEVERIDGE J. MAIR, JAMES W. WESTHAVER, and FREDERICK D. ROSSINI. *Ind. Eng. Chem.*, **42** (1950), pp. 1279-86.

The authors present the results of a theoretical study of the fractionating process of adsorption based on the concepts used in the theoretical analysis of fractional distillation processes, that is, by considering fractionation by adsorption analogous to fractionation by distillation. Equations are derived for determining the separation factor for binary solutions and for calculating the height equivalent to a unit theoretical stage of separation. Experimental results are given for the separation factor as a function of concentration for several solutions, including benzene n-propylbenzene, benzene and ethylbenzene, benzene and n-hexane, and benzene and cyclohexane. Experimentally determined results are given for the height equivalent to a unit stage of separation.

Petroleum Hydrocarbons—Separation and Analysis by Adsorption. BEVERIDGE J. MAIR. *Ind. Eng. Chem.*, **42** (1950), pp. 1355-60.

The author summarizes the work done during the past 15 years by the API Research Project No. 6 on the development and use of the fractionating process of adsorption as a tool for the separation and analysis of hydrocarbons. The author considers methods of operation, apparatus and materials, and makes a theoretical analysis of the process, giving equations for computing the separation factor and the height equivalent to unit theoretical stage of separation. Experimental data and results are given for the separation factor and for the height equivalent to theoretical stage of operation. Examples of the application of the process to the separation, analysis, and purification of hydrocarbons of various types and molecular weight ranges are presented. A bibliography of 18 references is included.

Liquid Phase Adsorption Equilibria and Kinetics. SAM EAGLE and JOHN W. SCOTT. *Ind. Eng. Chem.* **42** (1950), pp. 1287-94.

Problems in the design and operation of liquid phase adsorption columns have two broad aspects, first, the adsorption equilibria, second, the rate processes involved in attaining these equilibria. The authors present simple methods for measuring and expressing the equilibria and the rate processes Isotherms, x — y diagrams, selective adsorptive capacities, diffusion coefficients, and fracture resistance of adsorbents are reported. Several silica, silica-alumina, alumina, and charcoal adsorbents are prepared using toluene selective capacity, diffusivity, and fracture resistance as criteria. The system of toluene-iso-oxtane is recommended for evaluating and comparing adsorbent materials. The effect of temperature on the preparation of adsorbents and on adsorption equilibria and kinetics is briefly considered and discussed. Data are presented in considerable detail in tabular and graphical form.

Separation of Iso- and Normal Paraffins by Adsorption. HENRY J. HIBSHMAN. *Ind. Eng. Chem.*, **42** (1950), pp. 1310-14.

The author reports the results of a study of the selective adsorption at room temperature of normal paraffins with 5, 6, and 7 carbon atoms from iso-octane by the use of activated carbon. A particular activated carbon was found to be the only material that showed any selectivity. Countercurrent

These abstracts are selected from the current literature of science and technology, not including trade journals easily available. Photostatic copies of original articles will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by file, by abstracts, or in complete manuscript, also will be prepared and furnished by arrangement with the Laboratories.

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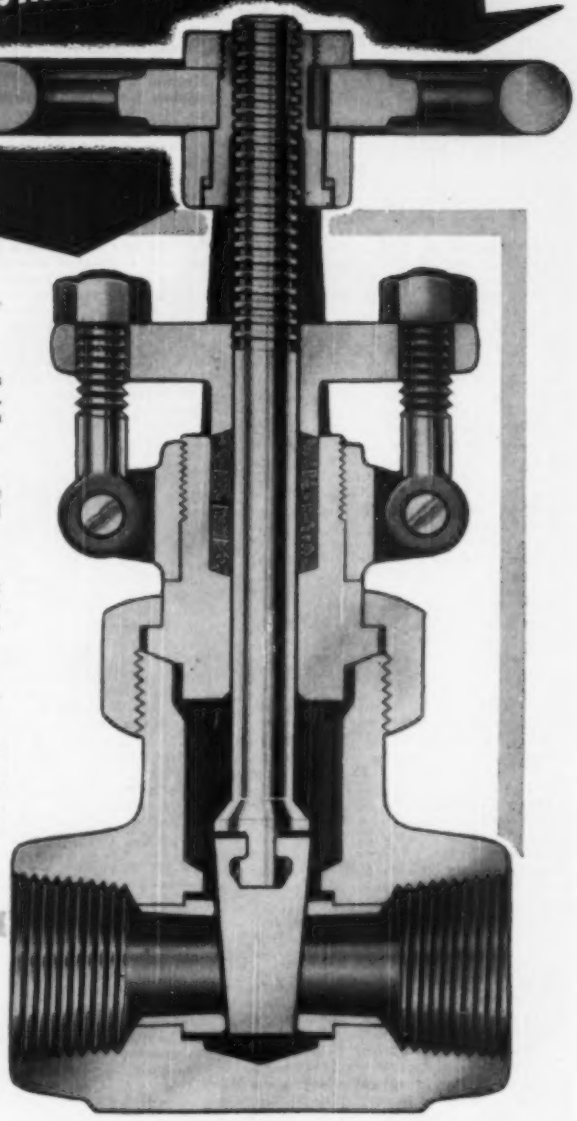

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flow of carbon and hydrocarbon is beneficial, indicating that an analogy exists between such solid adsorption and conventional extraction and distillation processes. Carbon was regenerated by thermal treatment at about 900° F., steaming at 580° F., or by washing with other hydrocarbons. If the latter procedure is used, and the solvent is properly chosen, it is not necessary to remove the wash solvent from the carbon before reuse, since selectivity is essentially unimpaired by the presence of the wash liquid. A flow plan for continuous separation using counterflow of liquids and solids is given.

Factors Affecting Efficiency of Separation (Separation of Cracked Gasolines by Chromatographic Adsorption). D. F. FINK, R. W. LEWIS, and F. T. WEISS. *Analytical Chem.*, **22** (1950), pp. 858-63.

The effect of important variables affecting the efficiency of separation of cracked gasolines into saturates, olefins, and aromatics was studied. Sharpness of separation increases as the particle size of the gel is reduced. For any given gel particle size the sharpness of separation is proportional to the length of the column used and inversely proportional to the square of the diameter of the column. The separation of a catalytically cracked gasoline can be accomplished in a column having an L/D^2 of 80 if gel passing a 200-mesh screen is used. In a column having L/D^2 of 230 separation can be made if 100- to 200-mesh gel is used. The gel should be packed in the column to the greatest possible extent. The hydrocarbon front should travel at a rate between 1 and 20 mm. per minute; and an eluting agent should be selected that will give a sharp interface with the hydrocarbon solution at the percolation temperature used. Small columns made from black iron pipe are as efficient as smooth-walled glass columns and are more easily packed with the finer gels.

Separation and Desulfurization of Cracked Naphtha. Application of Cyclic Adsorption Process. SAM EAGLE and CHARLES E. RUDY, JR. *Ind. Eng. Chem.*, **42** (1950), pp. 1294-9.

The adsorptive separation of aromatics and sulfur compounds from a high sulfur thermally cracked naphtha and the hydrodesulfurization of the aromatic extract obtained therefrom are described. The objective is the desulfurization of cracked naphtha without appreciable octane number loss. Cracked naphtha is separated preliminarily into a paraffin-naphthene-olefin raffinate and a high sulfur aromatic extract. Pentane is used as a stripping liquid. The extract so obtained is hydrodesulfurized and reblended with adsorption raffinate to yield a premium low sulfur gasoline blending component. The eight-column cyclic adsorption pilot plant is described and its operating features are discussed. Data are presented for several runs in the pilot adsorption unit and for the hydrodesulfurization of the high sulfur extract.

Separation of Cracked Gasolines by Chromatographic Adsorption. D. F. FINK, R. W. LEWIS, and F. T. WEISS. *Analytical Chem.*, **22** (1950), pp. 850-7.

The purpose of the investigation was to develop a practical method for separating gasolines into the principal hydrocarbon classes: saturates, olefins, and aromatics. The desire was to separate relatively large quantities of material to be used in engine testing of the hydrocarbons. The adsorbent characteristics and regeneration techniques necessary for the efficient and economical operation of a large-scale adsorption column are the subject. Silica gel had the greatest gel had the greatest capacity for adsorbing toluene from iso-octane and was the most responsive to repeated regeneration. The capacity of a silica gel for adsorbing olefins, in the same range of molecular weights, increases in the order straight-chain olefin branched-chain olefin cyclic olefin. The amount of gel required to separate a volume of solution can be calculated fairly accurately. It increases about 0.4 percent for each degree centigrade lowering of the temperature of the column. Gel can be regenerated at least eight times with less than 15 percent drop in capacity. Acetone proves to be the best regenerating solvent.

Simple Turbines in Fully Baffled Tanks—Power Characteristics. F. P. O'CONNELL and D. E. MACK. *Chem. Eng. Progress*, **46** (1950), pp. 358-62.

The purpose of the investigation was to study the relationship between the power and dimensions, that is length, width, and number of blades, for simple turbines. Turbines studied were of hubless rectangular-blade type with the blades at a 90° angle to the plane of rotation. The simple paddle is an example of a two-blade type of turbine. Tests were made for power consumption at various speeds in the turbulent region, and also in the viscous flow region. It was found that turbines can be correlated by the general equation:

$$Pg_c = KN^3L^{5-b}W^b$$

for the turbulent region and by the equation:

$$Pg_c = K'N^2L^{3-b'}W^{b'}$$

for the biscous region. Constants, K, K', b, and b' are functions of the number of blades.

Hydrocarbons from Natural Gas. H. H. JONES and JOHN T. COX, JR. *Chem. Eng.*, **57** (1950), pp. 110-2.

The authors describe the natural gasoline plant of the Richardson Gasoline Company at Fort Worth, which processes gas from the West Texas Keystone field. The plant was designed for 75 percent propane recovery and 98 percent recovery of butane and heavier homologs. The article gives data on the equipment and operating conditions and calls attention to the newer features in design.

Science and Technology

Products: Properties, Utilization and Analysis

The Fluorocarbons. J. H. SIMONS. *Chem. Eng.*, **57** (1950), pp. 129-36.

The author reviews the current status of the fluoro hydrocarbons and endeavors to answer questions that are currently being asked about these compounds. What are they? When will they be available? How much will they cost? And what are they good for? Some of these substances are thermally stable up to 1100° C., and chemically stable up to 500° C. The physical properties, such as boiling and freezing points, refractive indexes, viscosities, surface tensions, and the like, are given. Methods of making the compounds are briefly considered and the uses of the compounds are discussed, such as in refrigeration where they have a high resistance to chemical action, complete lack of toxicity, resistance to destruction in flames and no toxic products if they are destroyed. Their use in making paints, fabrics and solvents is regarded as impractical now, but possible some day. The use of such compounds as lubricants is an intriguing possibility and is discussed in some detail.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

2,3-Dimethylbutanol-3
n-Decyl mercaptan
n-Tetradecyl mercaptan
n-Dodecylsulfonic acid
N-Nitrosodiethyl amine
Benzopyrene
bis-(2-Hydroxy-5-chlorocyclohexyl)
1-Cyanobutene-1
1-Cyanobutene-3
2-Methylhexanol-1
2-n-Propylhydroquinone
Triethoxychlorosilane
N,N-Dimethylthioacetamid
Tetramethylethylene
β-Dimethyllauric acid
1,7-Dichloroheptane
1,8-Dichlorooctane
2,5-Octadiene
2,2-Diquinolyl
1,4-Dimercaptobenzene

Fractionator Calibration System—Binary vs. Multicomponent Test Mixtures. C. B. KINCANNON and EARL MANNING, JR. *Ind. Eng. Chem.*, **42** (1950), pp. 1386-8.

The authors felt that differences in the degrees of freedom and the rate of approach to thermal and phase equilibrium could make efficiency values based on multicomponent systems appreciably different from those based on binary systems. They therefore studied the efficiency of a distillation column, using systems containing from two to six components. Results from all mixtures showed an average efficiency value of 50 percent over a load range of 800 to 3000 ml. per hour overhead rate for the particular column. It was concluded that the efficiency of laboratory columns, evaluated with systems of like molecular weight and type, are independent of the number of components present in the test mixture.

Evaluating Petroleum Residua and Lubricating Oil Distillates, Adsorption Method. NEAL W. FURBY. *Analytical Chem.*, **22** (1950), pp. 876-81.

The object of the work reported was to develop a laboratory method for establishing the viscosity index-yield re-

Science and Technology

lationship for lubricating oil from residual oils and lubricating oil distillates, and to learn some of the properties of the oil and wax that can be made from any given stocks. Requirements were that a small quantity of sample should be used, and that the analysis should be completed in a relatively short time, and at reasonable cost. The procedure employs adsorption fractionation of a 200-gram sample. By blending fractions, oils are obtained covering the entire range of composition from low to high viscosity index. Property-yield relations are obtained over this range, including gravity, viscosities, viscosity index, percent sulfur, micro solid point, and refractive index. The work covered three petroleum residuals from different types of crude oil, one solvent extract, and one lubricating distillate.

Analysis of Natural Gas. Comparison of Two Chemical Methods. MARTIN SHEPHERD. *Analytical Chem.*, **22** (1950), pp. 881-5.

Reported are the results of studies of two volumetric methods of absorption-combustion analyses of a standard sample of the natural gas type. One method used depends upon the measurement of contraction on burning and of carbon dioxide produced; the other adds to these measurements that of the oxygen consumed. The latter, although not in general use, is shown to be the more accurate. Analyses were performed by laboratories cooperating with Subcommittee VII of Committee D-3 of the ASTM.

Determination of the Water Content of Motor Fuels. S. J. W. PLEETH. *Jour. Inst. of Petroleum*, **36** (1950), pp. 345-50.

The author reviews the literature of methods for determining water in motor fuels containing water-soluble components, such as methanol or acetone. Three methods were compared in the laboratory, the Dietrich method, using magnesium nitride; Schutz method using calcium carbide; and the Fischer method using iodine and sulfur dioxide in pyridine. Of these, the Fischer method gave the most consistently accurate results and is recommended as the preferential procedure.

Chromatographic Analysis of Gas Oils for Hydrocarbon Types. Examination of Techniques. R. J. CLERC, C. B. KINCANNON and T. P. WIER, JR. *Analytical Chem.*, **22** (1950), pp. 864-6.

The purpose of the work described was the determination of saturated hydrocarbons, monocyclic aromatics, dicyclic aromatics, and tricyclic aromatics. Although the procedure was applied largely to gas oils, it can, with limitations, be used for materials of higher boiling points. Three chromatographic methods of analysis were studied using a straight-run gas oil and a catalytically cracked gas oil. The use of a weak developer to displace a saturate band and to elute several aromatic bands allowed the desired separations into saturates, and into several aromatics. Data are presented in detail in tabular and graphical form and a bibliography of 14 references is included.

Interim Report of the Oxidation Panel of Standardization Sub-committee No. 6. *Jour. Inst. of Petroleum*, **36** (1950), pp. 336-44.

The object of the work was to standardize an oxidation/corrosion test to distinguish between straight mineral oils and heavy duty high additive oils on the basis of corrosion only. The oils were distinguished by the Sunbury test, or the Indiana test. Appendices to the article describe the development of the test methods and modifications of the Sunbury beaker corrosion test. Results obtained by cooperating laboratories are also given.

Fundamental Physical and Chemical Data

Refractive Index as a Function of Wave-Length for Sixty API-NBS Hydrocarbons. A. F. FORZIATI, National Bureau of Standards. *J. Research Natl. Bur. Standards*, **44** (1950), pp. 373-85.

Precise measurements of the refractive index of 60 purified hydrocarbons of the API-NBS series were made at 20, 25 and 30° C. and at seven wave-lengths from 6678.1 to 4358.3 A. An Abbe-type refractometer was used with constant temperature of the refracting prism to within ± 0.02° C. The light sources used were a mercury arc, hydrogen and helium discharge tubes and sodium vapor lamp, with suitable filters for each. Included among the compounds studied were 17 paraffins, 14 alkylcyclopentanes, 8 alkylcyclohexanes, and 21 alkylbenzenes.

Mass Spectra of Nonanes. F. L. MOHLER, LAURA WILLIAMSON, C. E. WISE, E. J. WELLS, H. M. DEAN, and F. G. BLOOM. *J. Research Natl. Bur. Standards*, **44** (1950), pp. 291-7.

The mass spectra of 35 nonanes were measured by the Mass Spectrometry Section of the Bureau of Standards. The paper presents the nonane spectra and also some empirical relations between the mass spectrum and molecular structure. The mass spectra for all isomers of paraffins with nine or less carbon atoms have now been published. The analysis of mixtures of nonanes will, in general, be impossible unless the sample is a cut containing comparatively few components.

Pure Gas Isotherms. W. K. LEWIS, E. R. GILLILAND, B. CHERTOW, and W. P. CADOGAN. *Ind. Eng. Chem.*, **42** (1950), pp. 1326-32.

The investigation was devoted to obtaining fundamental data on the adsorption of hydrocarbon gases on activated carbon and silica gel. The adsorption equilibria for eight of the lower hydrocarbons from methane to C_4's were measured, mostly at 25° C. and at pressures up to 1 atmosphere. In several cases the effect of temperature was studied up to approximately 250° C. and pressures up to 20 atmospheres. The adsorption isotherms were correlated by a modification of the Polanyi adsorption potential theory. Capacities of adsorbents for the hydrocarbon gases differ widely. Columbia G carbons adsorb 30 to 60 percent more than PCC carbons and two to nine times as much as silica gel at atmospheric pressure.

2,3-Dithiabutane: Low Temperature Heat Capacity, Heat of Fusion, Heat of Vaporization, Vapor Pressure, Entropy and Thermodynamic Functions. D. W. SCOTT, H. L. FINKE, M. E. GROSS, G. B. GUTHRIE and H. M. HUFFMAN. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 2424-30.

The organic sulfur compounds are divided into several structural classes and it was the purpose to study the thermodynamic properties of members of each class to determine the effect of structure on properties. The simplest member of the dialkyl disulfide class is 2,3-dithiabutane, or dimethyl disulfide. The heat capacity of this compound was measured over the temperature range 13 to 350° K. The triple point (188.44° K.) and the heat of fusion (2197.1 ± 0.1 cal./mol) were determined. The vapor pressure was measured over the temperature range 0 to 130 and an equation is given to fit the vapor pressure data. The normal boiling point is 109.75° C; the heat of vaporization is 9,181 ± 75 cal./mole at 298.16° K. The entropy of the liquid is 56.26 ± 0.1 cal./deg./mole. The entropy of the ideal gas at atmospheric pressure is 80.54 ± 0.3 cal./deg./mole at 298.16° K. Thermodynamic calculations were made for the free energy function, heat content, entropy, and heat capacity by methods of statistical mechanics for selected temperatures up to 1000° K.

Adsorption Equilibrium-Hydrocarbon Gas Mixtures. W. K. LEWIS, E. R. GILLILAND, B. CHERTOW, and W. P. CADOGAN. *Ind. Eng. Chem.*, **42** (1950), pp. 1319-26.

The possibility of separating gas mixtures by adsorption through the use of procedures analogous to distillation led to a study of the equilibria involved between hydrocarbon gases and of adsorbents such as silica gel or activated carbon. Gases like methane and ethylene can exist as a "condensed" phase at ordinary temperatures and pressures when in contact with adsorbents, thus making adsorption techniques attractive. To handle the same gases by distillation would require high pressure units with refrigerated condensers, which are expensive initially and in operation. The equilibria for binary mixtures of lower gaseous hydrocarbons on silica gel and several activated adsorption carbons were studied, and are reported. Pressures from a few hundred millimeters absolute to as high as 20 atmospheres were covered and temperatures from 0 to 40° C. were studied. In all cases mutual interference was found—that is, the amount of a gas adsorbed at a given partial pressure was always less in the mixture than it would have been if the other gaseous component had not been present. Several correlations to predict the vapor-adsorbate equilibria based on pure gas isotherms were studied.

Chemical Composition and Reactions

Petroleum as a Source of Organic Chemicals. J. L. EDGAR. *Chem. and Ind.*, July 1, 1950, No. 26, pp. 471-9.

The author reviews the many products that can be made from petroleum, stressing that the petroleum chemical industry is a new industry and only at its beginning. In America it is fifteen

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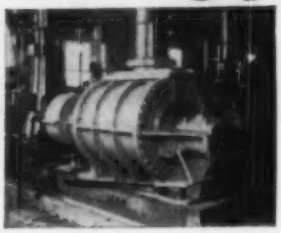

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years old, but is only starting in England in the current year. The basic feedstocks are briefly considered, as well as natural gas as a source of chemicals. Chemicals from the olefins are reviewed, including alcohols, ketones, chlorination products and derivatives of allyl chloride and of ketones. Oxidation of ethylene gives rise to glycol by hydrolysis of ethylene oxide. Phoduction of di-tert.-butyl peroxide from isobutane is briefly considered.

Cyclic Polyolefins. VI. Preparation of Cyclooctatrienes from Cyclooctatetraene. ARTHUR C. COPE and F. A. HOCHSTEIN. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 2515-20.

The reaction of cyclooctatetraene with two equivalents of sodium in liquid ammonia, followed by addition of ammonium chloride, was found to yield a mixture of 1,3,6- and 1,3,5-cyclooctatrienes. From this mixture the 1,3,6-isomer was separated in 94-96 percent purity by fractional distillation. Treatment of the mixture of isomers with potassium t-butoxide resulted in rearrangement of the unconjugated to the conjugated isomer, and this procedure gave a convenient synthesis for 1,3,5-cyclooctatriene. 1,3,5-cyclooctatriene was found to rearrange on heating to an isomer with lower refractive index and a nearly identical ultraviolet absorption spectrum. Three crystalline addition compounds of cyclooctatetraene with silver nitrate were prepared, and a crystalline addition compound of silver nitrate with 1,3,5-cyclooctatriene. These compounds are useful as derivatives, and for the purification of the hydrocarbons that can be regenerated from them.

Catalytic Hydrogenation of Carbon Dioxide to Higher Hydrocarbons. W. WALKER RUSSELL and GLENN H. MILLER. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 2446-54.

It is known that carbon dioxide can be catalytically converted to higher hydrocarbons at atmospheric pressure by reaction with hydrogen, and that the products are qualitatively similar to those obtained by the Fischer-Tropsch synthesis using carbon monoxide. The authors studied several types of copper-activated, cobalt catalysts at atmospheric pressure, and in a temperature range 175 to 300° C. Catalysts containing no alkali produced only traces of liquid hydrocarbons; if made alkaline with potassium carbonate or phosphate liquids were produced. It appears that alkali can act as a selective poison for methane-forming catalyst centers. Additions of small quantities of cerium oxides to the alkalized catalysts were effective in increasing synthesis life and catalyst stability. Alkalized, ceria-containing catalyst supported on natural kieselguhr produced only methane, but flux-calcined kieselguhr used as a support, gave a catalyst that synthesized nearly as much liquid hydrocarbons as unsupported catalysts of the same composition. Optimum synthesis temperature was approximately 225° C. Maximum liquid hydrocarbon yield obtained was 95 ml. per cubic meter of carbon dioxide. The activation energy for the over-all reaction was found to be 23.1 kcal.

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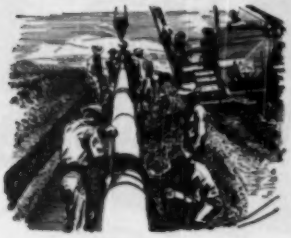

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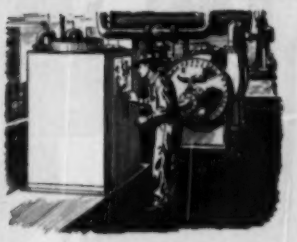

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Minnesota	Wisconsin
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Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, June 13, 20, 27 and July 4 and 11, 1950)

POLYMERIZATION AND CONVERSION

U.S.P. Re. 23,241. Process for Recycling Catalyst Fines in a Catalyst Conversion System. C. S. Reed and A. H. Schutte to The Lummus Company.

In the conversion of gases or vapors by means of turbulent suspended finely divided catalyst, wherein the finely divided catalyst is separated from the treated effluent by cyclone separation, a portion of the effluent gases or vapors with catalyst fines from the cyclone separation is directly recycled into the contacting zone.

U.S.P. 2,511,480. Polyperoxide Catalysts in Ethylene Polymerization. M. J. Roedel to E. I. du Pont de Nemours & Company.

Ethylene is polymerized at a temperature of 600-400° C. and a pressure of 200-3000 atmosphere in the presence of a polyperoxide from acetone and methylethylketone or from acetone and cyclohexanone.

U.S.P. 2,511,652. Apparatus for the Catalytic Conversion of Hydrocarbons. E. W. Shand to Sinclair Refining Company.

Details are claimed of an apparatus for the catalytic conversion of hydrocarbons in which the heat of the spent catalyst and the heat liberated in the regeneration of the catalyst are effectively employed to maintain the desired temperature in the reactor.

U.S.P. 2,512,562. Catalytic Reaction Apparatus. L. W. T. Cummings to Sun Oil Company.

A catalytic reactor is claimed which is suitable for conducting alternate endothermic and exothermic reactions, particularly the cyclic endothermic catalytic conversion of hydrocarbons with reactivation of spent catalyst. The reactor makes possible the storage within the contact mass of a large proportion of the exothermic heat evolved during the regeneration period for use during the subsequent on-stream period.

U.S.P. 2,512,586. Process and Apparatus for Carrying out Exothermic Chemical Reactions. L. A. Stengel to Commercial Solvents Corporation.

An apparatus is claimed for conducting exothermic gaseous reactions, such as the manufacture of methanol from CO and H_2. The apparatus makes possible temperature control, within the relatively narrow limits of the optimum reaction temperature range.

U.S.P. 2,512,698. Polymerization of Aromatic Polyfulvenes. R. B. Thompson and H. S. Bloch to Universal Oil Products Company.

An aromatic polyfulvene, such as dimethyl-p-difulvenobenzene, alone or in mixture with monofulvene, is subjected to polymerization at a temperature of 25-300° C. A resinous material is formed.

U.S.P. 2,513,243. Polymers from the Cyclic Dimers of Diolefins. R. F. Leary and J. D. Garber to Standard Oil Development Company.

A cyclic dimer of butadiene, piperylene, or isoprene, such as vinyl cyclohexene, is treated with a catalyst solution of an aluminum halide dissolved in an alkyl chloride of 1-3 C atoms. The resulting mixture is maintained at a temperature of 0-100° C. until a resinous polymer with a softening point of 98-112° C. is formed.

U.S.P. 2,513,244. Process of Polymerizing Butadiene-1,3. M. W. Swaney and A. H. Gleason to Standard Oil Development Company.

Butadiene-1,3 or piperylene is heated at a temperature of 130-200° C. until a major proportion of the diolefin is converted to a cyclic dimer. The temperature is then increased to 280-400° C. in the absence of oxygen to convert the dimer to a resin-containing product.

U.S.P. 2,513,995. Apparatus for Contacting Gases with Granular Solids. S. C. Eastwood and R. D. Drew to Socony-Vacuum Oil Company, Inc.

Details are claimed of an apparatus which is particularly suited for the conversion of higher boiling hydrocarbons to low boiling olefins within very short reaction times. The charge is rapidly heated to the desired temperature by direct contact with highly heated granular solid and is then rapidly cooled by contact with relatively cold granular solid.

U.S.P. 2,514,203. Vapor Phase Polymerization of Butadiene with Sodium. K. C. Eberly to The Firestone Tire & Rubber Company.

A slowly polymerizable petroleum butadiene is blended with butadiene derived from alcohol. The mixture is polymerized by the vapor phase method in the presence of sodium as a catalyst. Plastic polybutadiene is produced.

U.S.P. 2,514,288. Method and Apparatus for Carrying out Catalytic Reactions. E. W. S. Nicholson to Standard Oil Development Company.

An apparatus is claimed for carrying out catalytic reactions, e.g. the conversion of hydrocarbons in the presence of finely divided powdered catalyst. The reaction chamber is arranged concentrically in the interior of an outer regeneration chamber. Both chambers are interconnected by a stripping chamber arranged concentrically between them.

U.S.P. 2,514,332. Method of Producing Monomeric Olefins. E. V. Murphree to Standard Oil Development Company.

Isobutylene dimers and trimers are selectively depolymerized to form substantially pure isobutylene monomer by contacting a mixture of said polymers and butylene copolymers preheated to a temperature of 500-800° F. with a heated finely divided fluidized depolymerization catalyst and further treating the reaction effluent.

U.S.P. 2,514,371. Process Employing Fluent Solvents. C. L. Caldwell to Houdry Process Corporation.

In a hydrocarbon conversion process, a part of the fluent solid catalyst passed through a first conversion zone in contact with a first hydrocarbon fraction to be converted is supplied without preceding regeneration to a second conversion zone where it is contacted with a second hydrocarbon fraction. Spent catalyst leaving the second zone is regenerated together with the remainder of the catalyst from the first conversion zone. The process can, for example, be employed for cracking in the first zone a hydrocarbon fraction boiling higher than gasoline and for desulfurizing a normally liquid virgin hydrocarbon fraction in the second zone.

U.S.P. 2,514,497. Chemical Conversion Process. J. P. Jones to Phillips Petroleum Company.

In a process for non-catalytic cracking or otherwise converting hydrocarbons in gas phase, refractory pebbles are continuously passed through a preheating, a heating, and a conversion zone. In the heating zone, they are contacted with hot combusion gas to bring them to a temperature of 1650-3200° F. In the conversion zone, the hot pebbles are contacted with hydrocarbons to be converted at a temperature of 1500-3000° F. The preheating of the pebbles is effected by a stream of hot effluent from the conversion zone. A catalyst poison is introduced into this zone to retard or in-

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hibit catalytic action of the pebbles or of a carbonaceous deposit.

U.S.P. 2,514,866. Catalytic Conversion of Hydrocarbons. R. S. Hovey to Phillips Petroleum Company.

An isomerizable paraffin or cycloparaffin with at least 5 C atoms in the ring, substantially free of unsaturates, is passed under reconstructing, e.g. isomerizing conditions into contact with a liquid catalyst comprising 99-80 percent HF and 1-20 percent TiF_4 dissolved therein.

U.S.P. 2,514,928. Polymerizing Branch-Chain Hexadienes. E. T. Bishop and R. D. Sullivan to Shell Development Company.

An aqueous emulsion of at least one branch-chain hexadiene having a methyl group directly attached to a penultimate C atom of a straight chain of 5 C atoms is polymerized at a temperature of 50-150° C. in the presence of a tert. alkyl hydroperoxide. Light colored, non-toxic polymers are obtained.

U.S.P. 2,515,156. Fluidized Catalyst Apparatus. C. E. Jahnig and H. Z. Martin to Standard Oil Development Company.

An apparatus is claimed for effecting catalytic conversion of hydrocarbons with small particle size solid catalyst in a fluidized state. While most of the solid material is directly withdrawn from the bottom of the reaction vessel and is then regenerated, that part which passes upwardly with the reaction product is separated from these products by means preferably arranged in the upper portion of this vessel and is returned to its lower portion.

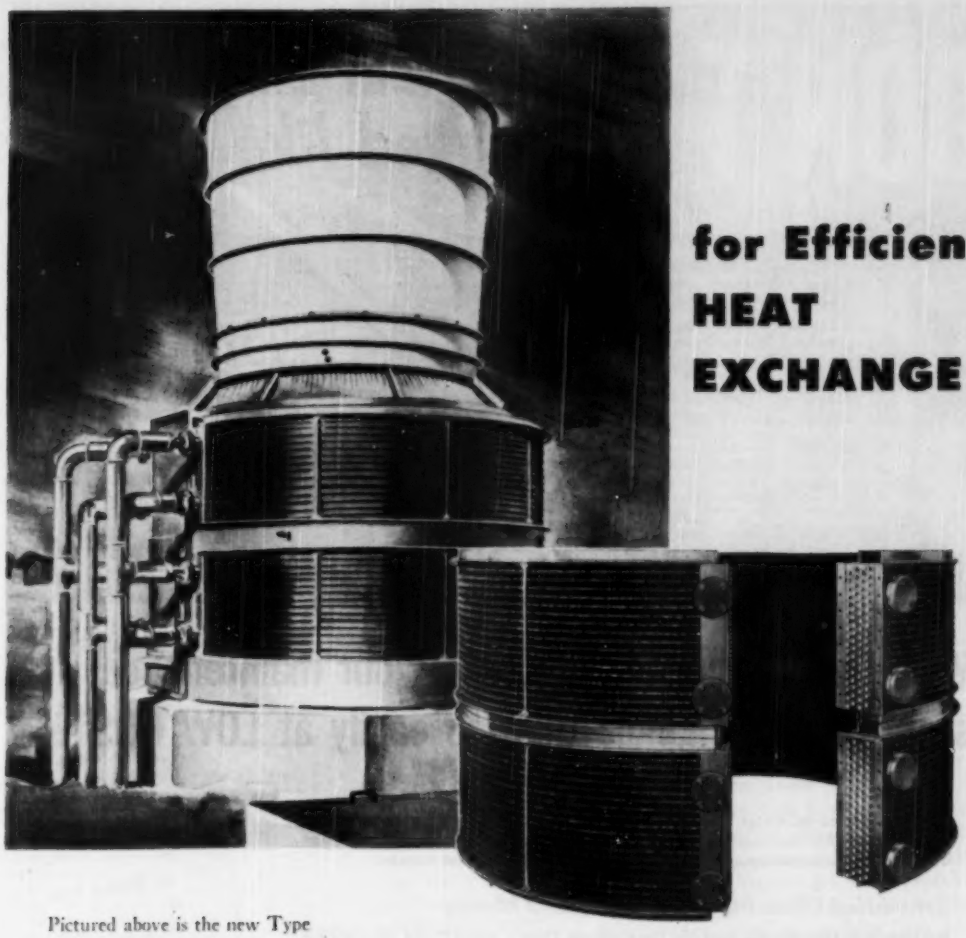
HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,511,453. Catalyst and Process for Carrying Out Hydrogenation Reactions. A. W. Barry to E. I. du Pont de Nemours & Company.

Acetylene present in small amounts in a gas mixture containing a lower olefin and at least one mol of hydrogen per mol of acetylene is selectively hydrogenated. The gas mixture is passed at a temperature of 125-350° C. over a catalyst prepared by treating a composition containing nickel oxide with a hydrogen-containing reducing gas at a temperature of 200-600° C. and thereafter sulfiding the resulting product in a special manner.

U.S.P. 2,513,022. Manufacture of Hydrogen. C. J. Helmers and P. H. Johnson to Phillips Petroleum Company.

Preheated hydrocarbon fluids are passed in a first stage over a catalyst favorable to carbonization as well as to the formation of CO_2 and H_2 (e.g. alumina impregnated with a minor proportion of at least one oxide of an alkali or alkaline earth metal) under such conditions that an amount of carbon between 0.05-0.3 pound per pound of catalyst is deposited thereon. In a second stage, steam admixed with sufficient air to maintain a reaction temperature of 1000-1500° F. is passed over the catalyst to form a H_2/CO_2-effluent containing



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less than 5 percent by volume of CO. Hydrogen is recovered therefrom and the catalyst is recycled to the first stage.

U.S.P. 2,513,994. Production of Synthesis Gas. D. D. Davidson to Shell Development Company.

In the cyclic production of synthesis gas by reacting methane with a solid reducible metal oxide, such as Fe_2O_3, in the absence of steam, the reaction which is periodically discontinued to reoxidize the reduced metal oxide is effected at a temperature of 1850-2300° F. and in the presence of an alkali metal oxide.

U.S.P. 2,514,282. Chemical Process for the Production of Carbon Monoxide. C. H. Holder to Standard Oil Development Company.

Pure CO useful for the Fischer-Tropsch synthesis is continuously produced by charging pure CO_2 to a fluidized mass of a reduced Group VI heavy metal oxide at elevated temperature and further treatment of the reaction effluent and spent catalyst in a manner claimed in detail.

U.S.P. 2,514,340. Production of Gases Rich in Hydrogen. W. H. Rupp to Standard Oil Development Company.

Details are claimed of a process for increasing the value of synthesis tail gas obtained by reacting CO with H_2 in the presence of a synthesis catalyst, by increasing the hydrogen content of the tail gas.

U.S.P. 2,514,546. Production of Cycloalkylperhydroindan Hydrocarbons. V. N. Ipateff and H. Pines to Universal Oil Products Company.

Hydrogen transfer between a branched chain olefin and a para-di-substituted aromatic hydrocarbon is effected in the presence of an acid-acting catalyst. One of the substituents is a hydrocarbon group containing only one hydrogen atom joined to the C atom in the aromatic ring. The arylindan hydrocarbon formed is hydrogenated, and the resulting cycloalkylperhydroindan hydrocarbon is recovered.

CATALYST, PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,512,327. Sulfuric Acid Recovery. T. P. Hawes and A. P. Giraitis to Standard Oil Development Company.

In the preparation of ethyl alcohol by absorbing ethylene in 100 percent H_2SO_4, diluting the acid extract formed with water, and distilling the diluted extract, the spent acid containing free carbon is mixed with pure hydrocarbon oil to separate the free carbon by flotation in the oil layer formed on settling. The acid layer is then reconcentrated, and the resulting acid is recycled.

U.S.P. 2,512,608. Synthesis Catalyst. F. J. Buchmann to Standard Oil Development Company.

A hydrocarbon synthesis catalyst is formed by spraying molten iron containing a promoter onto spherical particles of aluminum in a reducing atmos-

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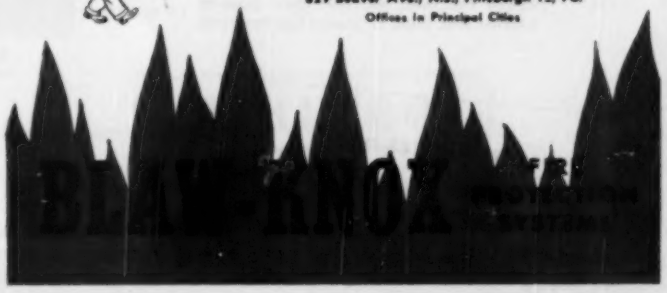

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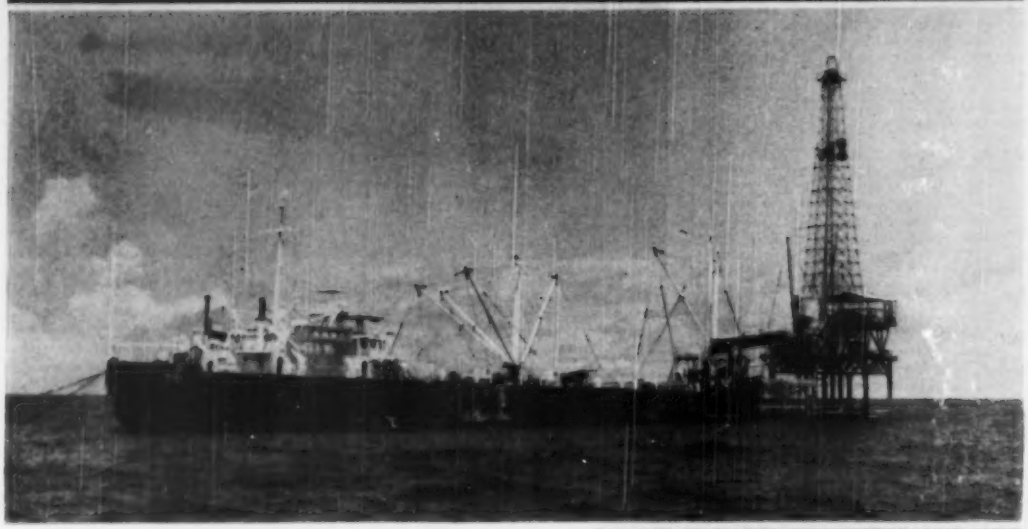

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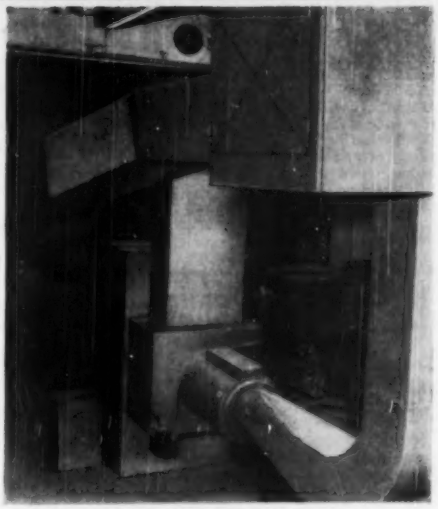

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phere, so that a thin coating of the iron on the aluminum particles is formed. This catalyst suffers little attrition during use.

U.S.P. 2,512,653. Process of Preparing Cr_2O_3-Hydrogenating Metal Oxide Catalysts. A. F. Kapecki to The Givaudan Corporation.

A hydrogenation catalyst is obtained by forming a flowable homogeneous mixture of 1-3 mols of CrO_3 and 1-2 mols of an acetate of Zn, Cu or Cd, or mixture of such acetates, and decomposing the homogeneous mixture by heating to 95-300° C.

U.S.P. 2,515,062. Regeneration of Mydrocarbon Conversion Catalyst by Solvent Washing. R. B. Smith to Sinclair Refining Company.

Spent hydrocarbon conversion catalyst is freed from deposited heavy hydrocarbons by repeated washing with an organic solvent containing as a detergent a petroleum sulfonate of Na, P, Ca or Ba.

U.S.P. 2 515,138. Method of Preparing a Friedel-Crafts Catalyst. H. G. Schutze to Standard Oil Development Company.

A solution of $AlOI_3$ catalyst of uniform activity is prepared by a process claimed in detail. The process makes use of methyl chloride solvent contaminated with a small amount of unsaturated or oxygenated organic compounds for forming the $AlCl_3$-solution.

CRACKING AND REFORMING

U.S.P. 2,510,994. Hydrocarbon Conversion with the Use of a Precipitated and Calcined Beryllium Oxide Catalyst. G. A. Mills to Houdry Process Corporation.

Hydrocarbons boiling above the gasoline range (e.g., gas oil) are contacted under cracking conditions, e.g. at a temperature of 750-1100° F. at a liquid space rate of 0.5-8 vols. of oil per vol. of catalyst per hour, with a catalytic mass the sole active catalytic ingredient of which consists of precipitated and calcined beryllium oxide. Lower boiling hydrocarbons, such as gasoline, are produced.

U.S.P. 2,511,936. Process of Producing Cycloalkadiene from Petroleum Oils. C. E. Morrell, H. W. Scheeline, C. S. Carlson, and H. J. Heineman to Standard Oil Development Company.

Details are claimed of a process for producing and recovering mono-meric cyclopentadiene of high purity by cracking a petroleum oil boiling in the heavy naphtha and gas oil range. The cyclopentadiene dimer formed in the cracking operation is heat treated to effect depolymerization.

U.S.P. 2,513,253. Apparatus for Handling Suspensions of Solids in Gases. G. W. Robinson to Standard Oil Development Company.

Details are claimed of an apparatus for handling at high temperatures a finely divided solid catalyst, or the like, suspended in a gasiform hydrocarbon

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medium, e.g. in the cracking of petroleum fractions in the presence of a powdered catalyst. Use of this apparatus reduces the amount of dropback of catalyst employed into the inlet line and the abrasion and failures of the interior thermal insulation of the reaction vessel.

U.S.P. 2,513,294. Process for Conducting Chemical Reactions. S. C. Eastwood and R. D. Drew to Socony-Vacuum Oil Company, Inc.

Details are claimed of a process for rapidly heating vapor phase hydrocarbons to an endothermic reaction temperature and then rapidly cooling the reaction mixture. The process is particularly useful in the cracking of hydrocarbons by means of a downwardly passing granular heat transfer material bed.

REFINING

U.S.P. 2,511,206. Process for Producing Hydrocarbons. R. L. Hasche to Tennessee Eastman Corporation.

Acetylene and propylene are separated from a gas mixture containing them and ethylene, as obtained, for example, by pyrolytic decomposition of hydrocarbons, such as propane. The acetylene and propylene are simultaneously removed from the mixture by absorbing them in polyethylene glycol ether.

U.S.P. 2,511,478. Deasphalting and Dewaxing Hydrocarbon Mixtures. H. C. Myers to Socony-Vacuum Oil Co., Inc.

A hydrocarbon mixture containing asphaltic materials and wax is mixed with a mixture of more than 0.75 percent by volume of liquefied normally gaseous hydrocarbons and the balance an organic carbonate. The asphalt is separated from the mixture obtained. The ratio of organic carbonate to liquefied normally gaseous hydrocarbons in the deasphalted mixture is then raised to 3:1 to 1:3 for separating wax.

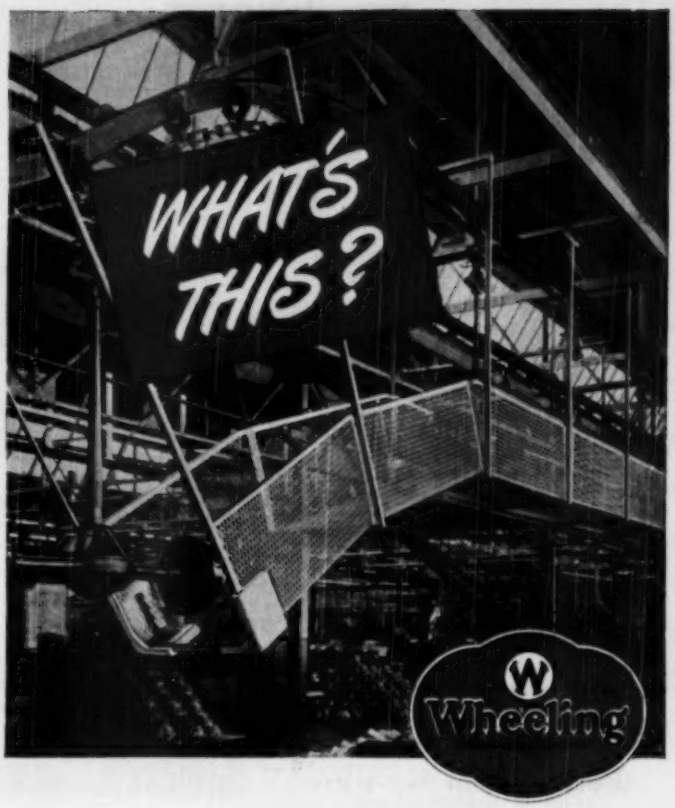
U.S.P. 2,511,711. Process for Separating a Mixture of Isomeric Xylenes. H. P. Hetzner and R. J. Miller to California Research Corp.

Details are claimed for separating o-, m-, and p- xylene from their equilibrium mixture by repeated fractional distillation to separate an o-xylene fraction, then selectively sulfonating the m-xylene, and finally recovering it by hydrolysis of its separated sulfonic acids.

U.S.P. 2,512,040. Method and Apparatus for Recovering Hydrocarbons from Gaseous Mixtures by Freezing. R. L. Slobod to The Atlantic Refining Co.

A gaseous mixture containing normally gaseous hydrocarbons is passed in heat exchange and out of direct contact with liquid nitrogen at a temperature lower than that at which the gas will condense. The liquid nitrogen in turn is maintained in heat exchange and out of direct contact with liquid nitrogen at a reduced pressure to control its temperature. Normally gaseous hydrocarbons can thus be frozen out from noncondensible gases, e.g., from soil gases obtained in geochemical prospecting for petroleum deposits.

U.S.P. 2,512,297. Motor Fuel. C. B. Bis-



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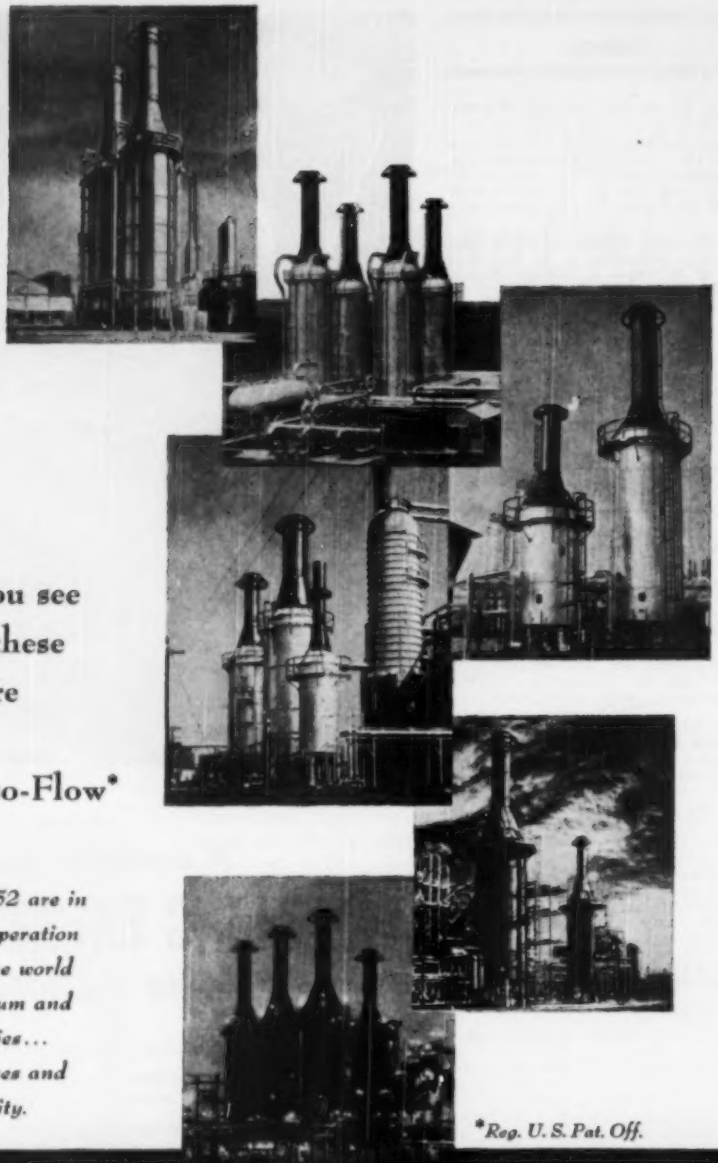

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Patents

Well and G. A. Sayers to E. I. du Pont de Nemours & Co.

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U.S.P. 2,512,435. Emulsion. R. G. Mitchell, H. C. Tait, C. L. Gilbert, and W. David to Shell Development Company.

A stable oil-in-water emulsion can be obtained from a mineral concentrate comprising 50-80 percent mineral oil and 50-20 percent of a mixture of a) water soluble alkali metal salt alkyl sulfate with 10-18 C atoms, b) an alcohol with hydrophilic and oleophilic properties, and c) a certain type of oil-soluble alkali metal petroleum sulfonate soluble in petroleum-ether.

U.S.P. 2,513,252. Distillation of Diolefins. B. Robertson to Standard Oil Development Company.

A contaminated diolefin stream is distilled in the presence of 1-4 percent by vol. of a petroleum gas oil having substantially no vapor pressure at the distillation temperature. The distilled diolefin has a purity in excess of 98 percent.

U.S.P. 2,513,669. Motor and Aviation Fuels. W. A. Partridge and H. J. Alty to Anglo-Iranian Oil Co., Ltd.

A stabilized gasoline for use in internal combustion engines contains in addition to tetra ethyl lead a lead salt of a fatty acid as stabilizer.

U.S.P. 2,513,767. Gaseous Mixture. S. W. White, Detroit, Mich.

A gaseous fuel mixture of high calorific value and low ignition point consists of city gas and petroleum ether. The latter is a petroleum fraction boiling from 40-60° C. It is present in a proportion of 5-10 pounds for every 1000 cubic feet at 70° F. of the city gas.

U.S.P. 2,513,768. Gaseous Fuel. S. H. White.

The fuel according to this patent is closely related to that of U.S.P. 2,513,-767. Propane is here employed instead of city gas. Preferably, the mixture contains 1 part of the petroleum ether on 5-9 parts of propane.

U.S.P. 2,513,769-70. Gaseous Fuel. S. W. White.

According to both these patents, which are closely related to U.S.P. 2,513,767-8, mixtures of city gas, propane and petroleum ether are employed. According to 2,513,769, 5-9 pounds of propane and 1 pound of the petroleum ether are employed for every 100-600 cubic feet at 70° F. and atmospheric pressure of the city gas. U.S.P. 2,513,770 differs from 2,513,769 in that a mixture of petroleum

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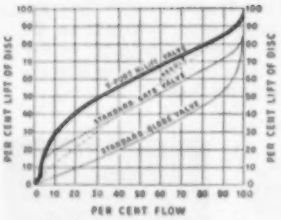

Flow characteristics of the Honeywell Hi-Lift Hand Control Valve far surpass those of conventional designs . . . offer favorable comparison to the precision of such diaphragm operated control valves as the Honeywell Series 700.

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WORLD'S LARGEST ORGANIZATION FOR ADVANCED INSTRUMENTATION AND CONTROL

THE Honeywell Hi-Lift Hand Control Valve is ideal for use where automatic regulation is not necessary or advisable. Designed to afford micrometer adjustment of flow, it contains an indicating scale to show percentage of stem travel to 1% and an inner valve capable of responding to such close correction. Inset illustration shows the simple and easy-to-read scale and the curve at left portrays the superior flow characteristics of the Hi-Lift over conventional valve designs.

The Honeywell Hi-Lift is available with v-port or parabolic discs . . . in sizes from ¼" to 12" . . . straight through or angle . . . for pressures up to 600 lbs. . . . with body of Bronze, High-Tensile Iron or Cast Steel . . . and with Bronze or Stainless Steel trim. Available, too, with electric motor for remote control applications.

Call in your local Honeywell engineer for detailed information about the Hi-Lift and such other Honeywell Process Control Specialties as: Transfer Valves, Liquid Level Devices, Cylindrical Plug Valves and the Honeywell Space-Saving Bypass. *Write, today, for a copy of Bulletin #242-1!*

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MINNEAPOLIS
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VALVE PRODUCTS

ether and of ethyl ether is employed.

U.S.P. 2,514,018. Fuel Compositions. A. Wachter and N. Stillman to Shell Development Company.

The additive described in U.S.P. 2,514,017 for lubricants is here employed in a leaded gasoline fuel for spark ignition internal combusion engines to obtain a corresponding effect; 0.01-0.3 percent by weight of the additive are used.

U.S.P. 2,514,294. Distillation of C_1-C_6 Hydrocarbon Mixtures. W. H. Rupp to Standard Oil Development Company.

Details are claimed for the fractionation of a mixture of saturated and unsaturated hydrocarbons containing diolefins and having 1-6 C atoms in the molecule.

U.S.P. 2,514,399. Process for Resolving Emulsions. W. H. Kirkpatrick and D. L. Wilson to Visco Products Company.

An oil-in-water petroleum emulsion is resolved by the action of a water dispersable product obtained by the reaction of a polyalkylene glycol and a detergent forming acid or its ester with at least 8 C atoms in an aliphatic carbon chain with the elimination of water at temperatures of 150-210° C. A ratio of at least 1 mol. of acid per mol. of glycol is employed in this reaction, but less than that theoretically required for complete esterification.

U.S.P. 2,514,580. Separation of Hydrocarbons. A. E. Hirschler to Sun Oil Company.

A mixture of two hydrocarbons of the same degree of saturation is treated for its separation with a granular adsorbent, such as silica gel or activated carbon, in the presence of an added third hydrocarbon having not more than one double bond per mol. more than the starting hydrocarbons. The selective adsorbability of one of the latter is increased by the additive.

U.S.P. 2,515,006. Modified Acid for Tertiary Olefin Extraction. B. E. Hudson, Jr., to Standard Oil Development Company.

Tertiary olefins are selectively absorbed from hydrocarbon mixtures also containing normal olefins by contacting the mixture with an aqueous solution of a mixture of an organic sulfonic acid (e.g. benzenesulfonic acid) and a poly basic mineral acid (e.g. H_2SO_4) in specific proportions.

U.S.P. 2,515,126. Process for Extracting Liquid Hydrocarbons from Solids and Apparatus Therefor. J. P. Labour to The Gasoline Research Industrial & Commercial Company, Inc., Panama.

An apparatus is claimed for extracting liquid hydrocarbons dispersed in a solid medium. The apparatus makes it possible to recover liquid hydrocarbons which have been dispersed in an aqueous colloid and subsequently congealed to form a solid mass by reducing the size of this mass by shredding. The operation effects the separation of the solid material and the hydrocarbons.

U.S.P. 2,515,134. Separation of Butadiene from Hydrocarbon Gases with Cu-

Fire brick are placed in an upright position on the B-5 burner. This advanced design provides greater radiation surface to increase the heating efficiency of your fuel. The STAINLESS STEEL gas port produces efficient, safe, quiet atmospheric conversions and POSITIVELY ELIMINATES A FLASH-BACK IN THE VENTURA ON LOW PRESSURE GAS. Air-cooled heads assure longer life, lower maintenance.

We will gladly quote prices and specifications on the B-5 for low pressure gas for all types of steel fire boxes and sectional boilers. Please furnish the following information:

1. Make, Type, serial number of boiler.
2. Total load boiler will have at maximum rating.
3. Width of firebox between water legs.
4. Length of firebox available.
5. Average gas pressure available on header with estimated drop through valves and fittings to burner manifold.
6. Gravity and B.T.U. of gas to be used.

Zallea Expansion Joint News

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Expansion Joint of the Month

Designed to Meet a Need

UNIVERSAL EXPANSION JOINT

Zallea Stainless Steel Universal Expansion Joints, capable of absorbing combined axial and lateral movements in high temperature lines, have wide application in refineries, chemical, public utility and other industrial plants where it is difficult to anchor the piping and isol te the axial movement of the line from the lateral. The Universal Joint, absorbing movement in all planes simultaneously, reduces the number of anchors required, and also reduces the loads on the supporting steel work, simplifying the erection of today's complex piping. Each Zallea Stainless Steel Universal Expansion Joint is specifically designed to fit the requirements of each individual application. Send us your problem, stating the amount of axial and lateral movement anticipated, the maximum pressure and temperature to be encountered. This involves no obligation, of course. And, ask for Catalog 47—It's free!

Zallea Brothers
890 Locust Street
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THE Zallea Stainless Steel Universal Expansion Joint was designed to meet the need for a medium capable of absorbing movement in high temperature lines *in any direction*—axially, laterally, angularly, or any combination of these. Illustrated here are the many ways in which this versatile joint may function. In each case, the rectangle shows the original position of the expansion joint.

CASE 1—Axial Movement Only

A Universal Expansion Joint is usually not required unless this axial movement is combined with lateral or angular movement. However, it may be used for axial movement only where the traverse is such as to require more than one joint, and it is not possible to install an anchor between the two joints. In such cases, the tie rods take the place of an intermediate anchor.

CASE 2—Lateral Movement Only

The corrugated element on one end closes on one side and opens on the other, permitting a slight angular deflection. The corrugated element on the other end is similarly deflected in the opposite direction. The longer the section of pipe between the two corrugated elements, the greater the lateral deflection. Notice that the flanges remain parallel indicating that there is no bending in the adjacent pipe. Here the tie rods take the place of pipe anchors.

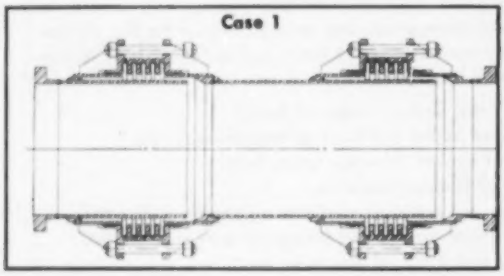
CASE 3—Axial and Lateral Movement

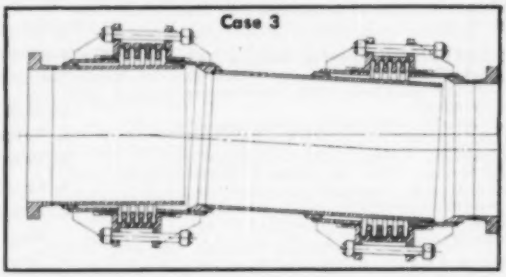
This is a combination of the movements illustrated in Cases 1 and 2, the most frequent application for Zallea Stainless Steel Universal Expansion Joints.

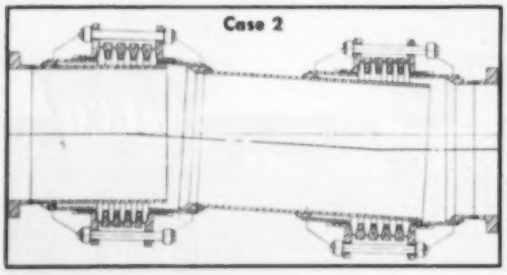
CASE 4—Axial Movement and Angular Rotation

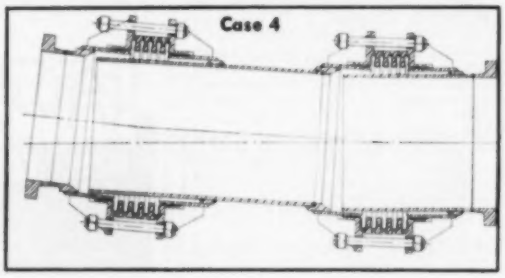
Here axial movement combines with angular rotation. Notice that flanges do not remain parallel, indicating that the pipe attached to the left end of the joint must bend, or that there is another joint at the other end of this pipe to compensate for the angular rotation. Axial and lateral movement may also be combined with angular rotation.

The limit rods shown in all cases are an essential part of the Zallea Stainless Steel Universal Expansion Joint. They are designed so that any two of the four rods will withstand the full line pressure in the event of failure of the anchors on the piping. They also distribute the movement equally between the two corrugated elements.









prous Chloride. E. V. Murphree to Standard Oil Development Company.

A continuous process is claimed for treating a gaseous hydrocarbon mixture to remove butadiene therefrom, using finely-divided CuCl as a selective adsorbent for the butadiene.

U.S.P. 2,515,140. Selective Solvent Separation of Unsaturated Hydrocarbons. C. P. Strand to Shell Development Company.

A fluid hydrocarbon mixture containing olefins and paraffins is contacted with an aqueous solution of $AgNO_3$ and an organic amine salt of an inorganic acid which forms water-soluble silver salts, e.g. monobutylamine nitrate. The weight ratio of the $AgNO_3$ to the amine salt shall be 0.2-8. The absorption of the unsaturated hydrocarbons in aqueous $AgNO_3$-solution is increased by the amine salt.

U.S.P. 2,515,141. Regeneration of Caustic Solutions. J. B. Stripling to Socony-Vacuum Oil Company, Inc.

A doctor-sweetened mixture of hydrocarbons is stabilized by contacting a body of aqueous alkaline solution employed for extracting H_2S from a hydrocarbon mixture with a body of unstable, doctor sweetened hydrocarbons containing lead until the latter body is stabilized and the aqueous solution is regenerated. The regenerated alkaline solution is then separated from the stabilized doctor-sweetened hydrocarbons.

U.S.P. 2,515,155. Apparatus for Separating Solids from Gases. J. C. Munday to Standard Oil Development Company.

An apparatus is claimed for separating solids from gases, particularly powdered catalyst from hydrocarbon vapors. A plurality of cyclones is employed which are disposed in sets within a single shell.

DESULFURIZATION

U.S.P. 2,511,251. Removing Sulfur Compounds. C. F. Feasley to Socony-Vacuum Oil Company, Inc.

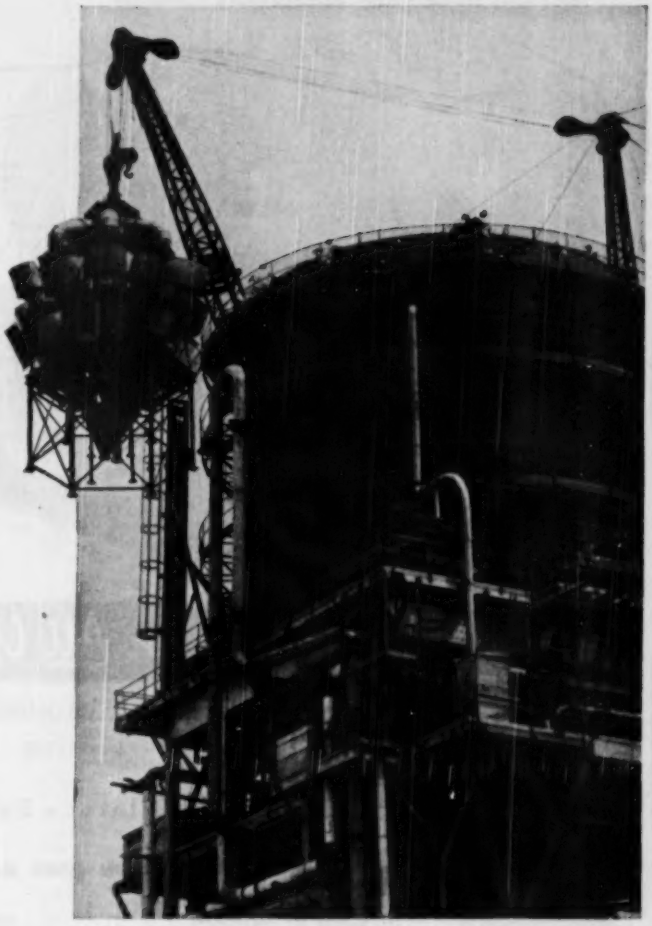
A mixture of hydrocarbons containing organic sulfur compounds condensible with carbonyl compounds, such as thiophene, is contacted with formaldehyde or another aldehyde compound in the presence of a catalyst consisting of an absorbent inorganic oxide, such as activated clay, at a temperature of 300-450° F. for 0.75-12 hours. Desulfurization is effected.

U.S.P. 2,512,570. Desulfurization of Hydrocarbon Oils. A. F. Sartor to Shell Development Company.

Sulfur-bearing hydrocarbon oil is contacted under hydrogenation conditions with a nickel sulfide catalyst prepared by mixing nickel carbonate with powdered inert carrier material, such as diatomaceous earth, and adding an aqueous solution of NH_4OH or/and its salts, drying, calcining, and sulfiding.

U.S.P. 2,514,997. Method for Removing Sulfur and its Compounds from Non-

BUELL 'GOES TO THE TOP'
in catalyst recovery



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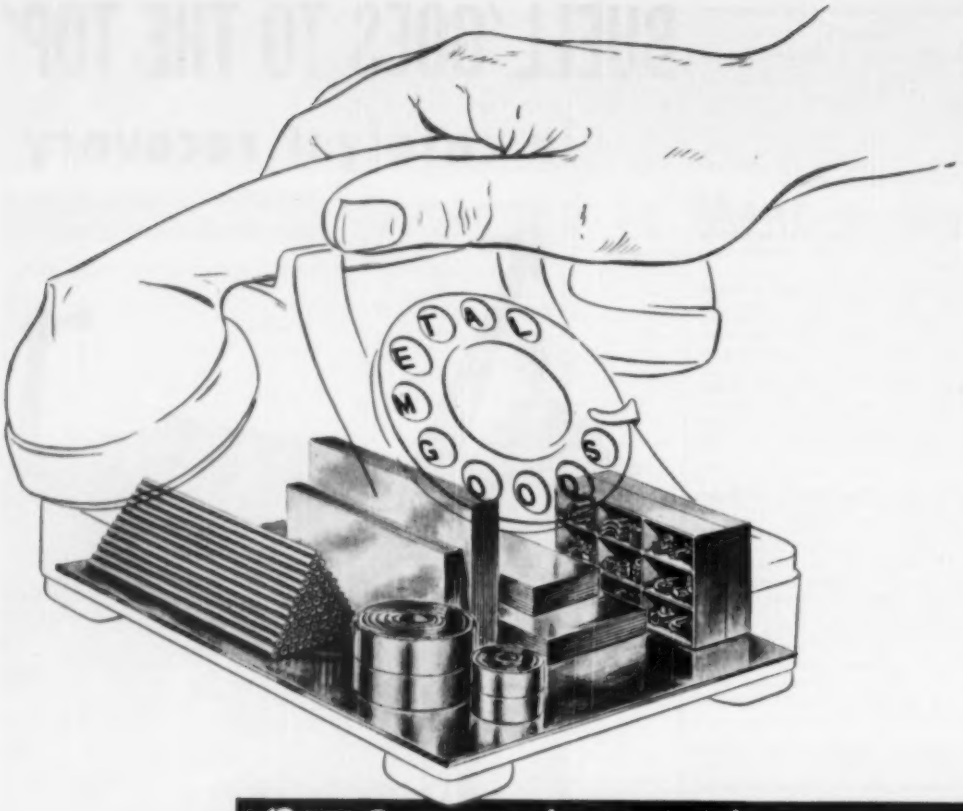

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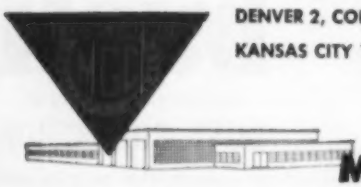


METAL GOODS CORPORATION

Patents

aromatic Hydrocarbon Fractions. C. M. Floyd to Standard Oil Development Company.

A non-aromatic hydrocarbon fraction containing sulfur and/or its compounds is contacted with a poly-olefin glycol having a mol. wt. of 400-4000, e.g. polyethylene glycol, under conditions to form a raffinate and an extract phase. Substantially sulfur-free hydrocarbons are recovered from the raffinate.

U.S.P. 2,515,131. Process for the Regeneration of Desulfurizing Catalyst. C. Mack to Standard Oil Development Company.

Mercaptans and organic sulfides are removed from petroleum oils boiling in the gasoline range by contact with bauxite containing iron oxide as an impurity at a temperature of 600-900° F. The spent bauxite is burnt with oxygen-containing gas at a temperature of 1000-1400° F. and then treated with ammonia for complete regeneration.

HEAVY OILS AND WAXES

U.S.P. 2,511,250. Stabilized Extreme Pressure Lubricants. J. S. Fawcett to Gulf Research & Development Company.

Lubricating oil is compounded with chlorinated hydrocarbon and a small amount of the triethanolamine salt of the oil soluble petroleum sulfonic acids. The chlorinated hydrocarbon imparts extreme pressure characteristics to the lubricant, while the second additive inhibits the corrosive properties of the first named additive.

U.S.P. 2,511,630. Liquid Hydrocarbon Lubricant, and Additive Therefor, and a Process of Making the Additive. M. B. Goren and D. E. Adelson to Shell Development Company.

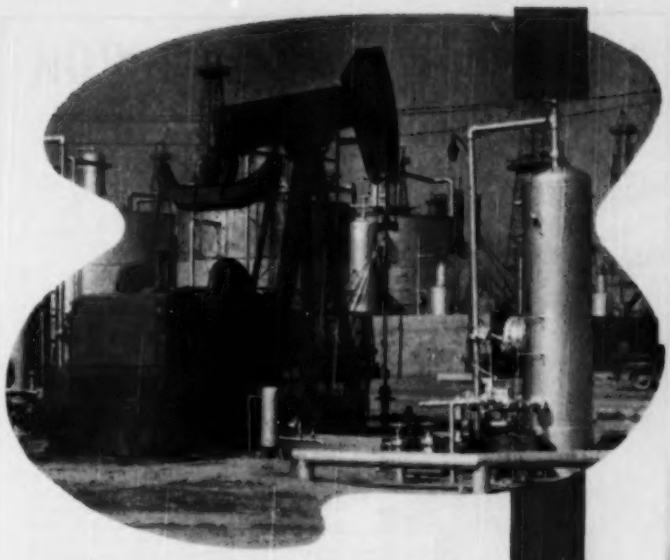
Lubricating liquid hydrocarbon contains a minor amount of a neutralized P and S containing reaction product obtained by reacting a phosphorus sulfide with an unsaturated cyclic ketone fraction having at least 12 C atoms and other specified characteristics. The additive stabilizes the lubricant against deterioration and improves its anti-wear properties.

U.S.P. 2,511,731. Extreme Pressure Lubricants. G. M. McNulty and E. B. Cyphers to Standard Oil Development Company.

A mineral base lubricating oil contains 1-20 percent by weight of a condensation product obtained under specific condition from a chlorinated kerosene or chlorinated wax and a dialkyl dithiophosphoric acid alkali salt with 1-6 C atoms in each alkyl group. The additive imparts extreme pressure characteristics to the lubricant.

U.S.P. 2,511,744-50. Antioxidants for Mineral Oil Lubricants and Compositions Containing the Same. H. G. Smith, T. L. Cantrell, and J. G. Peters to Gulf Oil Corporation.

A mineral lubricating oil contains a minor amount of an oxidation inhibiting additive. This additive is a non-resinous condensation product of N-dimethylami-



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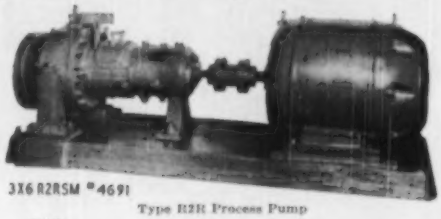
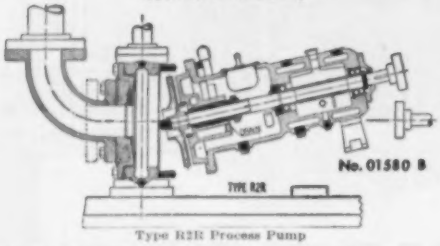
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

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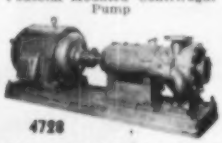
Close Coupled Centrifugal Pump

3510
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

4043 AA
Pedestal Mounted Centrifugal Pump

3833
Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



4728
Double Pedestal Bearing Centrifugal Pump

3556
Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

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Representatives in Principal Cities

Patents

line and formaldehyde with xylidine, (U.S.P. 2,511,744), or with diphenylamine (U.S.P. 2,511,745), or with N-amylaniline (U.S.P. 2,511,746), or with N-diethyltoluidine (U.S.P. 2,511,749), or with N-diethylaniline (U.S.P. 2,511,750), or a corresponding condensation product of N-dimethylaniline and formaldehyde, only (U.S.P. 2,511,747), or such a condensation product of an N-diethyltoluidine and formaldehyde, only (U.S.P. 2,511,748).

U.S.P. Re. 23,243. Lubricating Grease Composition. A. A. Bondi to Shell Development Company.

A mechanically stable, thermally reversible, non-bleeding lubricating grease comprises a major amount of a lubricating oil and 5-25 percent of a soap derived from a mixture of a hydroxy fatty acid and a hydrogenated fatty acid. These saponifiable materials shall each have at least 6 C atoms. Sodium and lithium soaps are preferred.

U.S.P. 2,512,359. Lubricant Compositions Containing Beryllium Carboxylates. J. F. McGrogan to The Atlantic Refining Company.

A hydrocarbon lubricating oil contains a relatively small amount of a Beryllium salt of a carboxylic acid with 6-18 C atoms, such as stearic acid. The additive improves the detergency of the oil upon use in internal combustion engines.

U.S.P. 2,512,444-5. Antioxidants for Mineral Oil Lubricants and Compositions Containing the Same. H. G. Smith, T. L. Cantrell, and J. G. Peters to Gulf Oil Corporation.

A mineral lubricating oil contains a minor amount of a non-resinous condensation product methyl ether of amylphenol with N-dimethylaniline and formaldehyde. According to U.S.P. 2,512,445 phenyl salicylate is employed in place of the amylphenol compound in the formation of the condensation product. The additive inhibits oxidative deterioration of the oil.

U.S.P. 2,512,784. Lubricant. D. E. Adelson to Shell Development Company.

A mineral lubricating oil contains a minor amount of a stable, non-corrosive organic reaction product obtained by reacting NH_4HS-H_2S with an oxygen-containing organic compound until 4-26.4 percent sulfur enters the reaction product. The additive stabilizes the oil against deterioration and improves its anti-wear properties.

U.S.P. 2,513,061-3. Antioxidants for Mineral Oil Lubricants and Compositions Containing the Same. H. G. Smith, T. L. Cantrell, and J. G. Peters to Gulf Oil Corporation.

A mineral lubricating oil contains a minor amount of a non-resinous condensation product of benzaldehyde, N-dimethylaniline and formaldehyde. The benzaldehyde can be replaced by diethylaminobenzaldehyde (U.S.P. 2,513,062), or by dimethoxybenzaldehyde (U.S.P. 2,513,063). Oxidative deterioration of the oil is inhibited by these additives.

U.S.P. 2,513,600. Lubricant Compositions Containing Organic Oxidized

and Sulfurized Esters. H. G. Smith, T. L. Cantrell and J. G. Peters to Gulf Oil Corporation.

A mineral lubricating oil contains a minor amount of an ester of a monohydric alcohol and an oxidized sulfurized fatty acid derived from an unsaturated fatty oil having an iodine number above 70. The ester shall contain at least 2 percent of combined sulfur. The additive confers improved pressure carrying properties on the oil.

U.S.P. 2,513,680. Lime Base Grease. J. E. Schott and E. L. Armstrong to Socony-Vacuum Oil Company, Inc.

A lime base grease is composed of lubricating oil, lime soaps of fatty acids, a small proportion of a calcium salt of a monocarboxylic fatty acid with not more than 6 C atoms, and a small proportion of a lime salt of phosphoric acid. The first of these two additives imparts temperature stability in excess of 200° C. to the grease, and the second additive imparts storage stability thereto.

U.S.P. 2,514,017. Lubricant. A. Wachter and N. Stillman to Shell Development Company.

A mineral lubricating oil contains 0.001-5 percent by weight of a compound of the formula $\begin{matrix} R_1 \\ \\ R_2 \end{matrix} \!\!> N{-}N{=}O$ wherein R_1 and R_2 are hydrocarbon radicals with a total of 6-20 C atoms. Examples of the additive are diisopropyl and dicyclohexyl nitrosamine and N-nitrodiphenylamine. Combustion chamber deposits of internal combustion engines are eliminated or materially reduced by use of the additive.

U.S.P. 2,514,286. Lubricating Grease and Method of Preparing the Same. A. J. Morway to Standard Oil Development Company.

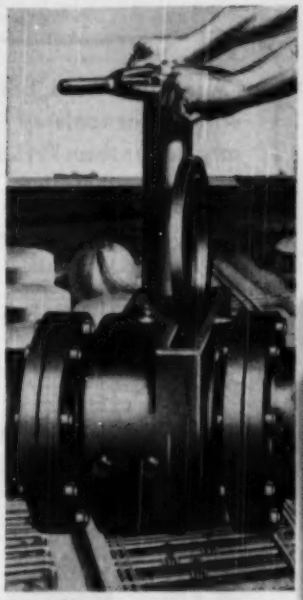
A soap of higher and lower fatty acids is prepared in mineral oil from a mixture of a molar proportion of C_{16}-C_{20} fatty acids and at least ½ molar proportion of C_2-C_4 fatty acids and alkali metal hydroxide by heating to at least 450° F. while stirring. A fine dispersion of the soap in the mineral oil is thus formed and cooled with stirring to 200-250° F. The resulting lubricating product is liquid until subjected to mechanical stress, whereupon it solidifies.

U.S.P. 2,514,311. Process of Manufacturing an Aluminum Base Grease. A. E. Calkins, R. Darley, and A. Beerbower to Standard Oil Development Company.

Unfinished Venezuelan distillate mineral oil (62 percent) of lubricating oil viscosity and containing certain polar compounds (1-1.5 percent) is combined with 32 percent of finished Coastal oil as a diluent and 6 percent of aluminum soap from saturated fatty acids with 12-22 C atoms and further treated by heating and rapid cooling to prepare a stable lubricating grease of smooth texture.

U.S.P. 2,514,330. Mixed Base Lubricating Greases. A. J. Morway and R. O'Halloran to Standard Oil Develop-

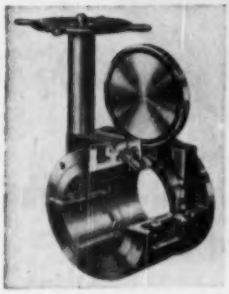
NOW BLIND RIGID LINES
in the COST-CUTTING
HAMER hand wheel operated way



When Hamer Line Blind Valves were introduced years ago, the old expensive and hazardous way of blinding pipe lines with a spectacle bolted between companion flanges became obsolete. The Hamer family of positive, one-man operated line blinding units has now grown until there is *a Hamer Line Blind Valve for every application*—EVEN FOR BLINDING RIGID LINES where no endwise movement is possible.

The new "RIGID" Line Blind Valve solves the problem of blinding inflexible lines in refineries, process plants, tankers and other ships... wherever rigid piping installations must be opened and closed. *It's speedy and cost-cutting*—one man can reverse the plate in one minute. It's *safe*—enclosed plate slot prevents spilling line fluid. *It's positive*—there's nothing like a solid plate for a permanent, leak-proof shut-off.

Positive shut-off without pipe line movement!



Actuated by the hand wheel, a smooth-turning ball bearing mounted ring gear moves the sliding internal sleeve in a straight line to clamp and release the plate, eliminating the need for spreading the line. "RIGID" Line Blind Valves conform to A. S. A. Standards for face-to-face dimensions of steel wedge gate valves. In planning new layouts, or modernizing existing installations, use a gate valve for blocking but specify Hamer "RIGID" Line Blind Valves at every point where quick, one-man operated, POSITIVE SHUT-OFF will be required.

LEFT—"RIGID" LINE BLIND VALVE

RIGHT—SPOOL-TYPE LINE BLIND VALVE

SPEED, ECONOMY, SAFETY IN BLINDING FLEXIBLE LINES!

There are Hamer Line Blind Valves for every blinding application. All models feature cost-cutting "one-man, one-minute" operation, positive shut-off, and long service life. Write for full information.

Illustrated below are: 1—Spool-Type, side hand wheel. 2—Spool-Type, upright hand wheel. 3—"Tee" and "Ell" Type. 4—Economy 3-Bolt Type.

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Patents

ment Company.

Mineral base lubricating oil of a viscosity index of at least 80 is compounded with a mixed Na-Ba soap of fatty acids having an average of less than 18 C atoms. The molar ratio of Na soap to Ba soap shall be between 1:1 and 30:1. A slight excess of fatty acid is contained in the anti-friction bearing lubricating grease formed.

U.S.P. 2,514,331. Stabilized Lubricating Grease. A. J. Morway to Standard Oil Development Company.

A solid grease type lubricating composition consists of a mineral base lubricating oil, 0.2-15 percent by weight of finely divided silica of a certain average particle size, and 2.8-40 percent of alkaline earth metal soap. The grease is water resistant.

U.S.P. 2,514,625. Lubricating Oil Composition. T. I. Clausen and J. T. Rutherford to California Research Corporation.

An oxidizable mineral lubricating oil contains a small amount of a condensation product obtained by heating sulfur or selenium with a dialkyl sulfide containing at least 14 C atoms. The additive inhibits oxidative deterioration of the lubricant.

U.S.P. 2,514,979. Wax Composition Containing Propylene-Butadiene Polymer. W. R. Turner and R. G. Heiligmann to The Atlantic Refining Company.

A hydrocarbon wax contains 5-50 percent of a polymer of specific characteristics obtained from a propylene-butadiene mixture.

U.S.P. 2,515,015. Lubricating Oil Composition Containing Pour Point Depressant. E. Lieber and E. P. Cashman to Standard Oil Development Company.

A waxy mineral lubricating oil contains a condensation product from a chlorinated aliphatic compound having at least 10 C atoms and naphthalene obtained under special conditions and then reacted with a P and halogen containing compound of certain type, e.g. PCl_5. The additive has a pour depressing effect.

U.S.P. 2,515,024. Nonfoaming Hydrocarbon Oil Compositions. C. F. Trautman to Gulf Research & Development Company.

A hydrocarbon oil, e.g. a lubricant, contains an organo-silicon-phosphorus condensation product in which Si is linked to P through an oxygen atom. The additive is obtained by reacting a phosphorus acid compound or its alkali-metal salt with a silicon halide, of which reactants, at least one contains an unsubstituted or halogen-substituted hydrocarbon radical. The additive which is dispersed in the oil, decrease the foaming tendency of the oil.

U.S.P. 2,515,115. Nonfoaming Compositions. G. H. B. Davis and J. C. Zimmer to Standard Oil Development Company.

A mineral lubricating oil containing organic ester additives tending to cause excessive foaming is compounded with 0.001-10 percent by weight of an oil-

insoluble highly fluorinated aliphatic hydrocarbon with 5-50 C atoms and containing 60-80 percent F. The additive inhibits foaming of the composition.

U.S.P. 2,513,129. Lubricant Composition. E. Lieber and A. F. Cashman to Standard Oil Development Company.

A waxy mineral lubricating oil contains dissolved therein a Friedel-Crafts condensation product of a sulfurized highly chlorinated paraffin wax or kerosene with an aromatic hydrocarbon of less than 30 C atoms, such as naphthalene. This pour depressing condensation product shall have an average mol. wt. of 500-3000 and contain 10-30 percent by weight of chlorine and 2-20 percent of sulfur.

U.S.P. 2,515,133. Lubricating Grease. A. J. Morway to Standard Oil Development Company.

A lubricating grease consists of an oily lubricant thickened to grease consistency with 3-30 percent of a metal soap of aliphatic fatty material, 0.2-1 percent of a resinous, oil-soluble condensation product of diisobutyl phenol and a formaldehyde reacted with a nitrogen base, and 0.02-0.5 percent of phenyl beta-naphthylamine. The lightly colored grease is resistant to oxidation and to metal activation.

PETROCHEMICALS

U.S.P. 2,511,433. Process of Nitrating Kerosine. F. Fiala, Sr., Cleveland.

Details are claimed of a process for nitrating kerosine by treatment with HNO_3 of 40-45° Bé at room temperature at atmospheric pressure.

U.S.P. 2,511,454. Nitration of Paraffins. R. B. Bishop, W. I. Denton, and E. M. Nygaard to Socony-Vacuum Oil Company, Inc.

N-butane or n-pentane is reacted with a nitrating agent, e.g. HNO_3, at a temperature of 150-250° C. and a pressure above 150 psi. and with a space velocity above 0.1. High yields of the corresponding secondary mononitroparaffins are obtained.

U.S.P. 2,511,758. Production of Ethyl Alcohol and Alkylate. W. W. Weinrich to Phillips Petroleum Company.

Ethylene contained in gaseous mixtures together with higher aliphatic olefins and methane and hydrogen is converted to ethyl alcohol in the presence of a mineral acid catalyst with con-comitant alkylation of an isoparaffin by said higher olefins.

U.S.P. 2,511,787. Manufactured of Acetaldehyde. M. Randall, Berkeley, Calif.

Acetaldehyde is produced by a process claimed in detail from acetylene and an aqueous catalyst solution e.g. a solution containing a mercury compound and an oxidizing agent.

U.S.P. 2,511,810. Production of Ethyl Alcohol and Alkylate. P. M. Arnold to Phillips Petroleum Company.

The process of this patent is closely related to that of U.S.P. 2,511,758.

U.S.P. 2,511,818. Photochlorination of Paraffinic Hydrocarbons. J. A. Spina

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TYPE "R" MANWAY

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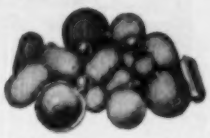

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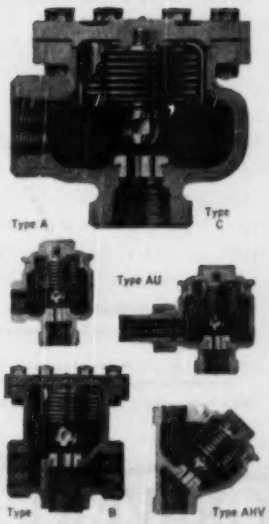

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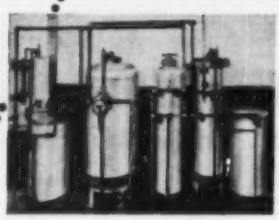
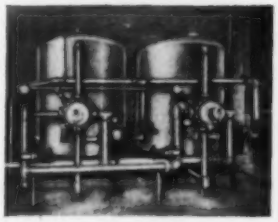
Graver chemists and technologists are continually evaluating the performance of many ion exchangers to determine the optimum operating conditions for each. As a result of this work the specific advantages of more than forty available Graver ion exchangers can be effectively applied to a wide range of processes.



PILOT PLANT OPERATION

Graver development engineers regularly conduct tests on small scale pilot units operating under simulated plant conditions. These tests serve to check laboratory experiments and to work out problems in mechanical design. This assures dependable operation of the ion exchange equipment under actual service.



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A background of thirty years' successful commercial experience is reflected in the design of Graver equipment. Graver chemical engineers have pioneered the commercial application of many new ion exchange processes. Dependable service is assured as a result of this experience.

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A DIVISION OF GRAVER TANK & MFG. CO., INC. EAST CHICAGO, IND.

to Hooker Electrochemical Company.

Paraffinic hydrocarbons with 10-16 C atoms are chlorinated with production of light colored materials of high stability and of special characteristics by reaction with gaseous chlorine under the influence of actinic light and under conditions claimed in detail.

U.S.P. 2,511,915. Production of Chloronitro Compounds. C. M. Himel to Phillips Petroleum Company.

Nitryl chloride is gradually added to an aliphatic olefin with at least 3 C atoms (e.g. isobutylene or butadiene) at such a rate that an excess of olefin is always present, and at a temperature of —30° to +30° C. Aliphatic chloronitro compounds are obtained.

U.S.P. 2,511,957. Tetralin Oxidation and Recovery of Hydroperoxide from the Oxidation Product. J. E. Wicklatz and T. J. Kennedy to Phillips Petroleum Company.

Tetralin is oxidized with free oxygen to form tetralin hydroperoxide, which is converted to its crystalline alkali salt. This product is hydrolized and further treated by solvent extraction to recover crystalline tetralin hydroperoxide of high purity.

U.S.P. 2,512,587. Method of Temperature Control in Nitration of Hydrocarbons. L. A. Stengel to Commercial Solvents Corporation.

In the manufacture of lower nitrohydrocarbons by nitration of saturated low-molecular hydrocarbons, the reaction temperature is regulated by the introduction of controlled amounts of a gaseous mixture containing free oxygen. The desired temperature increase, preferably to 390-460° C., is thus produced by reaction with the hydrocarbons.

U.S.P. 2,512,596. Production of Alkenyl Thiophenes. P. M. Arnold to Phillips Petroleum Company.

A 2-alkyl thiophene is reacted with formaldehyde at a temperature of 200-800° F. in the vapor phase in the presence of a catalyst comprising a relatively non-volatile strong mineral acid, its anhydride, or an acid reacting salt thereof. Alkenyl thiophenes are produced.

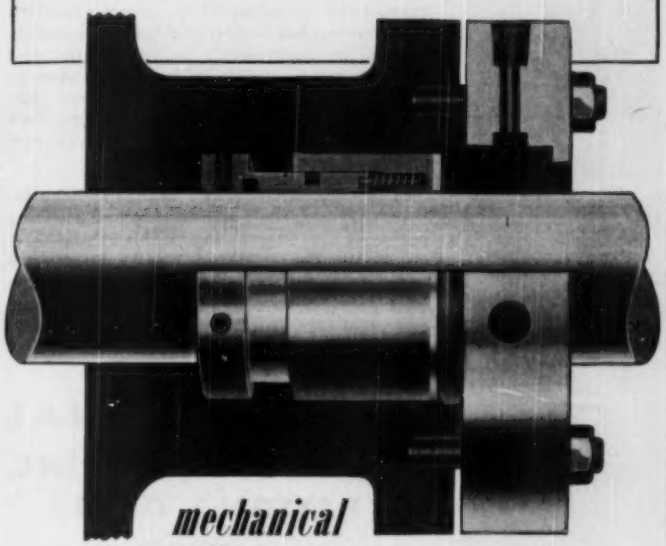
U.S.P. 2,513,092. Photochemical Preparation of Benzene Hexachloride. M. Gonze to Solvay & Cie., Brussels.

Benzene dissolved in an organic solvent of the aliphatic series which is liquid at 6° C. and inert to chlorine (e.g. CCl_4) is chlorinated by chlorine gas under irradiation by light at a temperature between 6° C. and the crystallization temperature of the solution employed. Benzene hexachloride is formed.

U.S.P. 2,513,179. Alcohol Derived From 1-Vinylcyclohexens-3. H. L. Johnson and F. J. Bondhus to Sun Oil Company.

1-Vinylcyclohexene-3 is treated with acetic acid and under esterifying conditions. The acetic acid monoester separated from the reaction mixture is heated with an aqueous alkaline solution to form the monohydric alcohol of 1-vinylcyclohexene-3.

High Pressure Sealing for Light Hydrocarbons



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Perfect **S**ealing on pumps handling light hydrocarbons is being recorded wherever this new custom-built mechanical seal is being used. DURA SEAL —Type P.S. provides non-lubricated sealing up to 600 lb. pressures. Consider, and compare, these features: It can be installed on your present equipment . . . requires no special sleeves or machining . . . no added lubrication system is needed . . . made of selected materials to operate under YOUR particular conditions.

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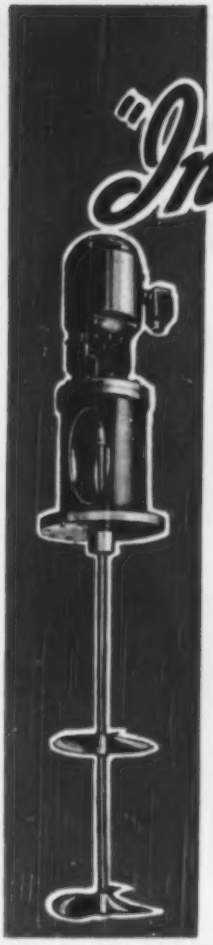

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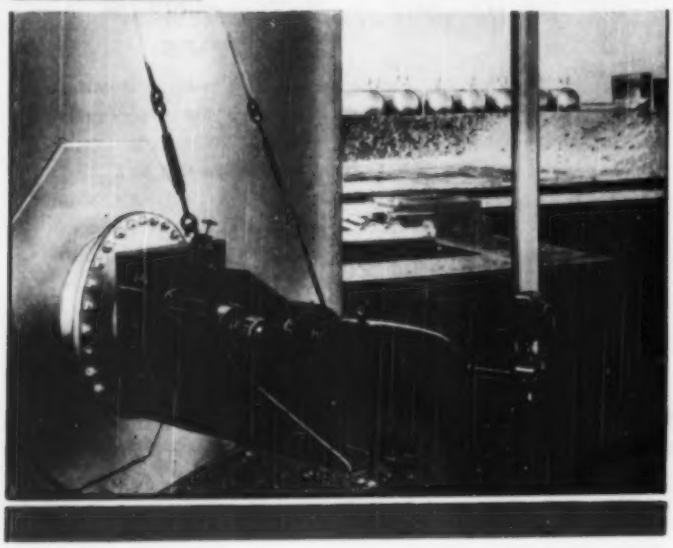


Patents

U.S.P. 2,513,180. Direct Production of Aromatic Vinyl Compounds and Thermoplastic Resins. W. E. Kemp to Dominion Tar & Chemical Company, Ltd.

A methyl benzene containing not more than three methyl groups is reacted in the liquid phase with acetylene in the presence of HF promoted by a mercury fluoride. Vinyl substituted aromatic compounds and their polymers are formed.

U.S.P. 2,514,291. Production of Secondary Butyl Alcohol. J. A. Patterson to Standard Oil Development Company.

Details are claimed of a process for producing sec. butyl alcohol from a hydrocarbon mixture containing butanes and 10-50 percent by vol. of n-butenes essentially free of isobutylene. The mixture is first subjected to extractive distillation in the presence of aqueous acetone, and a fraction thus obtained which contains 80-90 percent by vol. of n-butenes is contacted with 70-93 percent H_2SO_4.

U.S.P. 2,514,533. Diels-Alder Condensation Products of Certain Polyolefinic, Cyclic Hydrocarbon Fractions. H. S. Bloch to Universal Oil Products Company.

A surface active agent comprises a water soluble salt of an adduct of a mono- or dibasic acid compound containing the reactive group $—CH=C^2—C^1=O$ and a polyolefinic, cyclic hydrocarbon fraction boiling between 150-450° C., having an average mol. wt. of 200-400, an average number of olefinic bonds of 2.5-4 of which 40-70 percent are conjugated, and other specific characteristics.

U.S.P. 2,514,733. Sulfonation Method. M. J. Vold and R. W. Mertes to Union Oil Company of California.

Details are claimed of a process for the preparation of a concentrate containing a metal sulfonate dissolved in a lubricating oil. A petroleum lubricating oil fraction treated in a specific manner is subjected to sulfonation in the presence of an added volatile hydrocarbon diluent.

U.S.P. 2,514,961. Recovery of Aldehydes. N. Max to Shell Development Company.

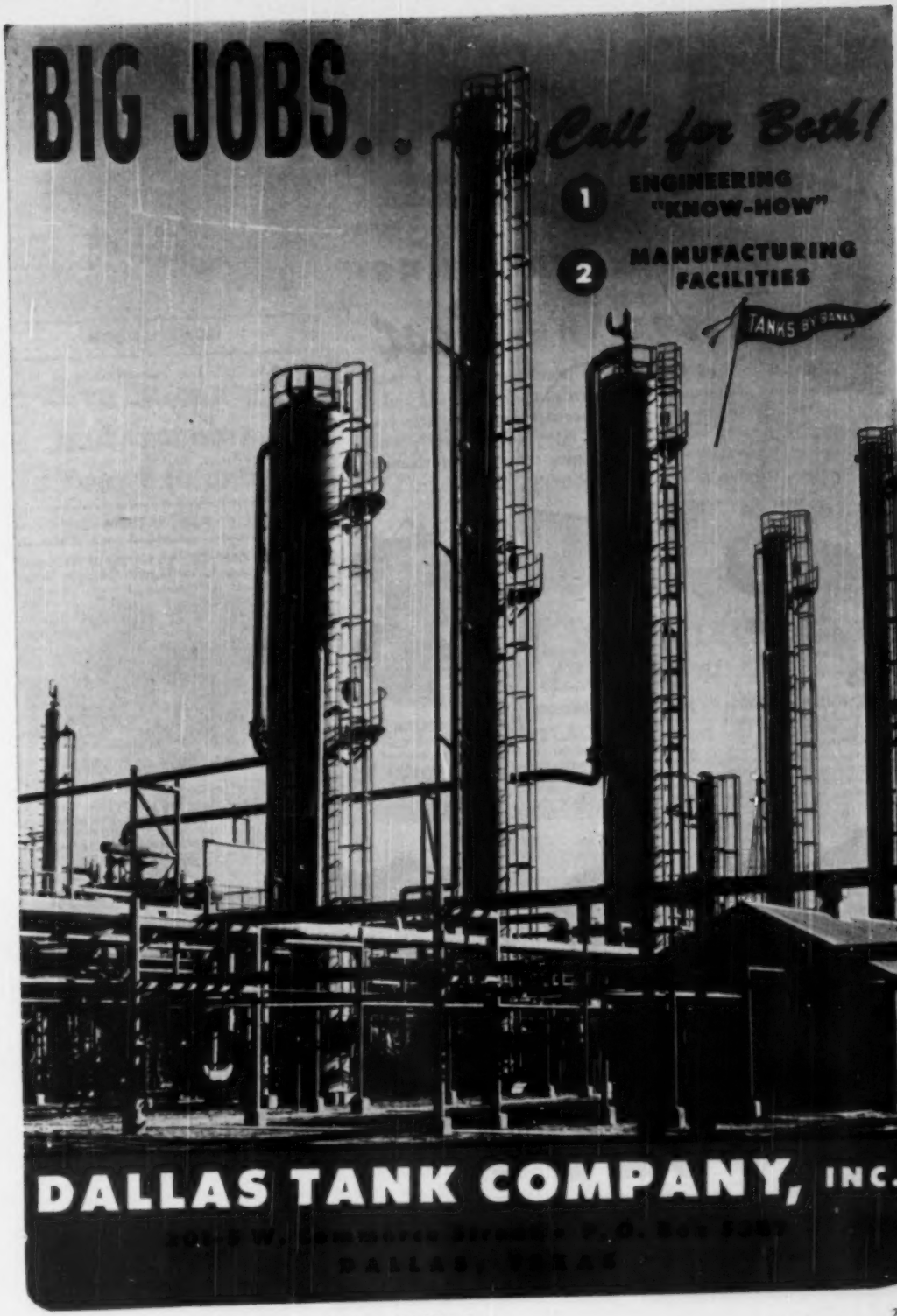
Aldehydes with 6-10 C atoms are recovered from the crude aldehydic reaction products obtained by the interaction of CO, H_2 and an olefin in the presence of a cobalt catalyst. Details of the recovering process are claimed.

U.S.P. 2,514,966. Refining and Concentrating Crude Unsaturated Aldehydes by Extractive Distillation. G. J. Pierotti, A. E. Handlos and C. M. Reider to Shell Development Company.

Alpha-beta unsaturated aliphatic aldehydes with 3-4 C atoms, e.g. acrolein, are separated from a crude containing them and obtained by the oxidation of the corresponding olefins, e.g. propylene. Details of the separating operation are claimed.

U.S.P. 2,514,967. Refining and Concentrating Crude Unsaturated Aldehydes. G. J. Pierotti to Shell Development Company.

The object of this patent is similar to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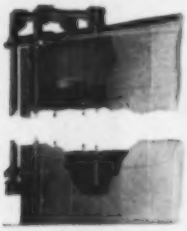
TYPE "E" FLAME ARRESTORS can withstand long exposure to fire. The "banks" have vertical straight through passages — minimizing entrainment and pressure drop, and are "extensible" for easy cleaning. 2" to 10" sizes.



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Patents

that of U.S.P. 2,514,966 and the claimed process is closely related to that of this patent.

U.S.P. 2,514,968. Purification of Crude Acrolein by Rectified Absorption. C. L. Dunn to Shell Development Company.

The object of this patent is similar to that of U.S.P. 2,514,966-7. The process for separating acrolein in a state of high purity from the crude is claimed in detail.

ISOMERIZATION

U.S.P. 2,513,103. Isomerization of Hydrocarbons. H. J. Passino to The M. W. Kellogg Company.

Paraffin hydrocarbons are isomerized by contact under suitable conditions with HF and DF_5 in the presence of an added low boiling isoparaffin, such as iso-octane, as a cracking inhibitor.

ALKYLATION

U.S.P. 2,510,937. Alkylation of Aromatic Compounds in Liquid Catalyst Solutions. H. J. Tadema to Shell Development Company.

Normally liquid olefins are reacted with alkylatable hydroxyaromatic carboxylic acids, such as salicyclic acid, mixed with at least 3.5 times of the weight of the acid of $SbCl_5$ at a temperature of 50-250° C. Alkylation-polymerization products are obtained.

U.S.P. 2,514,419. Phenol Alkylation Process. W. A. Schulze and C. E. Stoops to Phillips Petroleum Company.

A phenol is admixed with a monoolefin and with a C_7-C_9 paraffinic diluent. The mixture is contacted with an alkylation catalyst under suitable conditions. The reaction products are fractionated at super-atmospheric pressure in the presence of an intermediate boiling hydrocarbon diluent with 6-8 S atoms. The lower boiling diluent is separated overhead. Alkylated phenol is recovered.

James Tanham Retires From Texas Company Post

James Tanham, vice president of The Texas Company, in charge of industrial and public relations, The Texas Company, has retired after being with the company since the end of World War I. Tanham has served as assistant to the president and vice president in charge of sales. He was elected vice president in 1941.

Pennzoil Elects Officers

The Pennzoil Company has elected officers as follows: F. W. Alcorn, Oil City, Pa., vice president and secretary; H. W. Loveland of Bradford, Pa., treasurer; and R. W. Grunert, Bradford, controller.

M. A. Brewster, previously vice president and secretary, has retired, after 33 years with the company. He will continue as director of the Pennsylvania and California companies.

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Give Efficiency and Economy To *Your* Equipment

In any equipment handling liquid and gas phase materials entrainment occurs. York Separators eliminate entrainment! Higher vapor velocities can be used!

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- **Increased production through use of greater vapor velocities**

York does not make or sell separator vessels! In all cases our Separator Elements can be readily installed in your present equipment, eliminating the need for an additional vessel and piping.

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ENGINEERS AND MANUFACTURERS — 67 GLENWOOD PLACE EAST ORANGE, N. J.

York Separator Uses Extended in Refineries

Recent orders for York Separators reveal a multitude of refinery uses. Originally designed to improve the quality of lube distillates these separators are now widely used in *vacuum towers* to improve the quality of gas-oil charging stock to catalytic cracking units.

Among other uses for which York Separators are being purchased are: effecting complete separation and giving maximum yield of liquid products in *gas scrubbers;* recovering solvent free from asphalt in *extract vacuum towers;* obtaining a clean distillate in *vacuum tower lube rerun stills* giving as a result a substantial saving in subsequent treating operations; eliminating operating difficulties caused by entrainment in *soda regenerator towers;* eliminating mist in *acetylene separators;* effecting clean separation in *naphtha stripping towers;* separating vapor from liquid for efficient operation in *Dowtherm boilers;* insuring liquid-free gas in *air surge drums;* and providing clean, dry steam in *steam drums.*

York Solvent Extractor Now Used in Refining

Developed for chemical processing, the York-Scheibel multi-stage Solvent extractor is now being used in petroleum refining operations such as lube oil solvent refining with the usual solvents; caustic treating and caustic dehydration; acid treating; removal of aromatics; mercaptan and hydrogen sulphide removal from liquid stocks; petro-chemical product separations; and other liquid-liquid contacting operations.

2 Valuable Booklets for Better Process Operations

Solvent Extraction Booklet No. 12

Contains equipment description; applications; plant scale, pilot plant and laboratory information for all users of solvent extraction operations.

ENTRAINMENT SEPARATORS and MIST EXTRACTORS

Advantages of York elements in vacuum pipe still towers, stripping towers, gas absorbers, scrubbers, dehydrators, knockout drums, evaporators, etc.

Bulletin No. 11

YOURS FREE

York OTTO H. YORK CO., INC.
ENGINEERS AND MANUFACTURERS — 67 GLENWOOD PLACE EAST ORANGE, N. J.

SOLVENT EXTRACTION

The HEART of the Most Economical... Most Efficient . . . Extraction Process

YORK-SCHEIBEL Multi-Stage SOLVENT EXTRACTOR

Here is practical, economical and highly efficient equipment for performing all liquid-liquid contacting operations.

For present, or proposed, processes on a commercial scale, York engineers will design and build equipment of any size from 6 inch I.D. to 15 foot I.D. to process 100 gph or 10,000 bpd in 2, 10, 20 or over 50 stages. Pilot plant and laboratory columns from 1" to 6" I.D. are standard equipment.

High throughput capacity and high efficiency without limit to the number of stages, low stage height, low maintenance cost and low initial cost are features which no other equipment for performing similar operations can claim. Separating efficiency, in fact, is so high in a great many cases structural isomers can be separated to pure products.

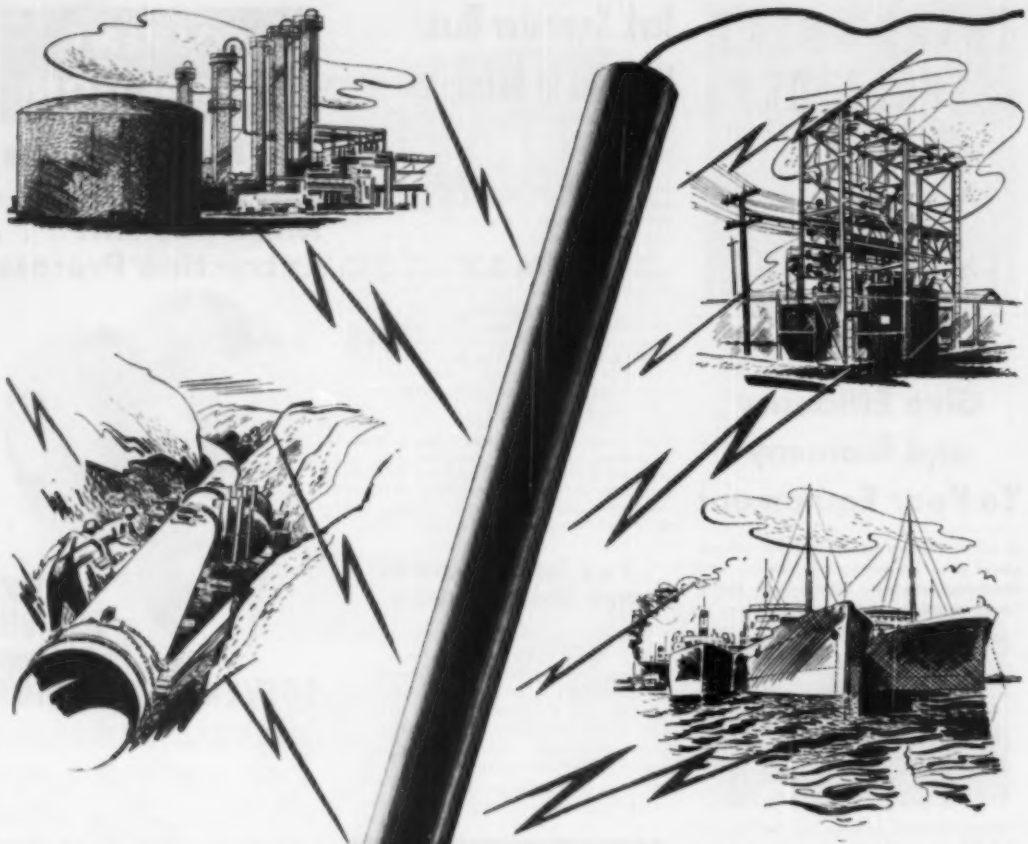
In addition to structural isomers, this Extractor should be considered for effecting separations where distillation cannot be employed conveniently or economically, as in close-boiling mixtures, azeotropic mixtures, non-volatile mixtures, materials from dilute solutions, impurities and color bodies and heat sensitive materials.

York-Scheibel Extractors (Patented) for laboratory, pilot plant or plant scale operations can be made of practically any material of construction; with any number of stages to give the precision of separation desired.

A 1" I.D. Laboratory Extraction unit with eleven stages is available from stock for use as a general research tool, for analytical work and for process development purposes.

We are in Chemical Engineering Catalog

York OTTO H. YORK CO., INC.
ENGINEERS AND MANUFACTURERS — 67 GLENWOOD PLACE EAST ORANGE, N. J.



PROTECT METAL STRUCTURES POSITIVELY UNDER ALL CONDITIONS!

"NATIONAL" GROUND ANODES

● Regardless of what the job is . . . how corrosive the environment – whether wet or dry, hot or cold – you can depend upon "National" ground anodes to provide efficient, positive protection against underground and underwater corrosion.

"National" ground anodes have proved themselves in 20 years of successful operation in many different parts of the country. They outlast other materials by a wide margin. They do not have to be dug up and replaced every couple of years. Because they use a controllable current source, it is simple and economical to adjust their protective output to match exactly the requirements of any installation.

For complete details on "National" ground anodes, write to National Carbon Division, Union Carbide and Carbon Corporation, Dept. PR.

The terms "National" and "Eveready" are registered trade-marks of

NATIONAL CARBON DIVISION
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
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MORE THAN DOUBLE THE USABLE LIGHT!

The biggest news since the invention of flashlights — the brand new leakproof "Eveready" battery — gives more than double the usable brilliant white light for critical uses than any other flashlight battery we ever made.

NO METAL CAN TO LEAK OR CORRODE

NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information about products described on these pages use the coupon below, circling the number shown for each item desired.

Electronic Ground Indicator

1 A balanced bridge circuit housed within a small explosion-proof aluminum box for mounting at the loading rack comprises Gilbert & Barker Manufacturing Company's new electronic ground indicator. When a proper ground is established by means of the ground clamp, a minute radio signal closes the circuit within the indicator, showing that the tank truck or transport has been properly grounded. The control circuit can be used to light a pilot lamp or sound a signal, or by connecting the indicator to the pump motor starting device, delivery of product can be prevented until the truck is properly grounded. Actual grounding of the truck takes place through one of the R. F. coils which is specially wound to have low d.c. resistance.

Giant Bore Plastic Tubing

2 Tygon flexible plastic tubing is now available in giant bore sizes ranging from 1⅜ to 2½-inch o.d., according to an announcement by its manufacturer. The U. S. Stoneware Company developed this larger bore plastic tubing "to meet a demand for a tough, translucent, non-toxic flexible hose for bulk handling of liquid food products, drugs and chemicals." Its translucency permits quick, visual inspection of flow, facilitates spotting obstructions or foreign materials, simplifies cleaning procedures. The manufacturer reports that it has an inherent ability to resist chemical attack makes it suitable for handling almost all acids and alkalies.

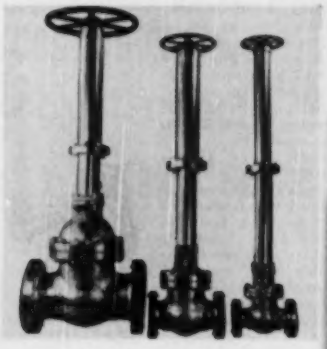
Worm Gear Speed Reducer

3 De Laval Steam Turbine Company's bulletin on IMO-worm gear speed reducers covers all the latest revised AGMA horsepower ratings. Described are how to gears are manufactured, types of speed reducers, selection tables, and a section on vertical speed reducers for cooling tower service.

Bolt Dies

4 A new tool added to the line of Ridgid pipe tools made by The Ridge Tool Company is the OOR-B bolt die, consisting of a ratchet drive ring and handle with 10 die heads fitted with ¼ to 1-inch button dies. (Both National coarse and National fine thread available). The set is furnished with a patented carrier which makes it easy to keep die heads from being scattered or lost. Manufacturer says that these die heads fit the Ridgid OOR pipe threader drive ring and that those who already own the OOR may purchase the bolt die heads alone. A related tool is the new Ridgid 3-way bolt dies No. 33B which offers 3 most useful sizes, ⅜, ½, ⅝ inch, all in one tool.

Floor Stand Arrangement



5 Kerotest Manufacturing Company has announced an improved, all-steel floor stand arrangement for the operation of valves by means of stem extensions. The usual cast iron floor stand has been replaced by a newly designed all-steel extension and steel yoke which connect directly to the valve bonnet. The cylindrical steel yoke and extension thus

FOR ADDITIONAL INFORMATION on products and literature mentioned in this section circle item numbers, cut out and mail this coupon. Prompt action is suggested so that data will be readily available.

PETROLEUM REFINER
BOX 2600, HOUSTON 1, TEXAS

Please have manufacturers send me, without obligation, additional information about items from September, 1950, New Equipment Section whose numbers are circled below:

1	2	3	4	5	6	7	8	9	10	11
12	13	14	15	16	17	18	19	20	21	22
23	24	25	26	27	28	29	30	31	32	33
34	35	36	37	38	39	40	41	42	43	44
45	46	47	48	49	50	51	52	53	54	55
56	57	58	59	60	61	62	63	64		

Name _____ Title _____

Company _____

Street address _____

City and State _____

PLEASE PRINT OR TYPE YOUR COMPLETE MAILING ADDRESS

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 282.)

provided, is reported to assure greater rigidity for the stem extension, greater strength with less bulk and dependable, easy operation of extended valve stems. All pipe lines or industrial valves can be accommodated by the product, according to the firm.

Bronze Globe Valve

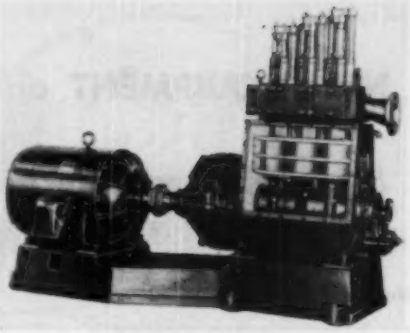
6 Jenkins Bros. has introduced a rapid-action, bronze lever gate valve with ball and socket double discs which adjust to seat surfaces. Swingtite, as the valve is called, has guided disc and roller action. The valve has a rated 125-pound steam service, 300 pounds cold oil, water, and gas, and is made in ½ to 2 inch sizes. Guide rims (A), on these discs rotate freely on the guide tracks (B) cast in the body, as the valve opens or closes. The malleable iron lever can be placed in four different positions with relation to spindle to suit installations.

Photoelectric Colorimeter

7 Bulletin No. 409 of Photovolt Corporation describes the Lumetron Photoelectric colorimeter Model 401 for colorimetric and turbidimetric analysis. Included are applications, advantages, method of operation, features, power line and battery operation, photoelectric pH determination, and clinical colorimetry. Also given are an accessories and replacement parts list.

Direct Flow Pump

8 Pump introduced by The Aldrich Pump Company incorporates the direct flow principle. The suction and discharge manifolds are separate units which are bolted to the forged steel working barrel. The valve assemblies and valve seats, which are held in place by the manifolding, are easily accessible. The stuffing box is removable to permit adapting other size plungers to the pump and note the pumping fluid flows through in a direct line, without being diverted. Three sets of wearing parts are necessary to cover a total range of pump sizes from 100 to 2450 hp. The hydraulic medium handled can be water, soluble oil in water, or hydraulic oil. The pump can be fitted with a by-pass valve to operate automatically with all types of accumulators.



Treating Boiler Feed Water

9 Boiler feed water can be traced by a new system of Worthington Pump and Machinery Corporation known as the Hot-Z which combines the advantages of both the hot process and the zeolite process. The temporary hardness is removed by lime and zeolite treatment while the zeolite removes the permanent hardness. The development of a styrene base resinous zeolite suitable for operation on hot treated water makes it possible to combine hot process treatment with its deaerating and silica reduction features with zeolite softening which assures uniform hardness reduction to 0.2 ppm. without addition of excess sodium alkalinity.

Blue Gasoline Dye

10 E. I. du Pont de Nemours & Company, Inc. announces Oil Blue A, said to be a 35 per cent higher strength blue gasoline dye developed especially for aviation gasolines to meet the demand for a product that will give desired color intensity at lower concentrations. Oil Blue A is a single component dye with a free flowing crystalline form which will not lump or cake on prolonged storage even at elevated temperatures. Approximate solubility in grams per 100 U. S. gallons are: straight run gasoline, 760-950; thermal cracked gasoline, 4150-1500; aviation gasoline, 570-760; and benzene, 28,400-32,000.

Cast Steel Valves

11 The Wm. Powell Company announces a new line of small size cast steel valves designed for high-pressure steam, boiler feedwater, by-pass, instrument and throttling. Known as integral bonnet valves, they are available in globe, angle and "Y" patterns, classes 1500 and 2500 pounds, in sizes ½ to 2 inches, inclusive. They have socket weld ends. Features include one-piece construction of the body and bonnet, deep packing chamber, long disc guide that centers the disc in the seat and prevents chattering in throttling service, hard-faced Stellite seat and disc, accessibility of all internal parts, and ease of disassembling valves.

Fire Fighting Foam

12 Rockwood Sprinkler Company offers a new double strength fast-flow foam for fighting flammable liquid fires. Among 22 advantages claimed are flows freely at subzero temperatures (—20° F.); foam blanket reseals if broken by trucks, hose, foot tracks; cuts shipping costs in half, can be used with latest types of fogfoam and foam nozzles in hose lines or fixed piping systems where proper proportioning is provided.

Pipe Scarfing Attachment

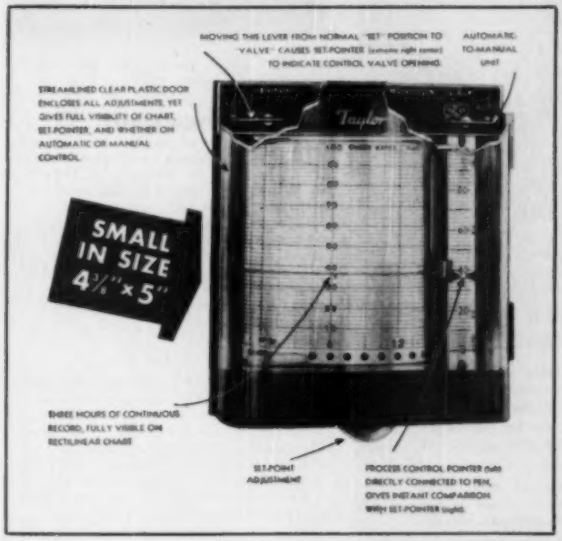
13 A pipe scarfing attachment has been developed for use with the Kinmont Universal power unit, manufactured by Roylyn, Inc. The attachment has a provision for vertical and horizontal adjustment of the cutting torch. Principal parts used in the attachment are heat treated aluminum alloy castings. Extension rods

Need More Data?

For additional information on New Equipment items or literature mentioned in this section, use the coupon on reverse side.

Prompt action is suggested so that data will be readily available.

Taylor's New Midget TRANSET* RECORDER


MOVING THIS LEVER FROM NORMAL "SET" POSITION TO "VALVE" CAUSES SET-POINTER (extreme right center) TO INDICATE CONTROL VALVE OPENING
AUTOMATIC-TO-MANUAL unit
STREAMLINED CLEAR PLASTIC DOOR ENCLOSES ALL ADJUSTMENTS, YET GIVES FULL VISIBILITY OF CHART, SET-POINTER, AND WHETHER ON AUTOMATIC OR MANUAL CONTROL.
SMALL IN SIZE 4⅜" x 5"
THREE HOURS OF CONTINUOUS RECORD, FULLY VISIBLE ON RECTILINEAR CHART
SET-POINT ADJUSTMENT
PROCESS CONTROL POINTER (left) DIRECTLY CONNECTED TO PEN, GIVES INSTANT COMPARISON WITH SET-POINTER (right).

Gives continuous 30-day chart record on 4⅜" x 5" panel space

PLUS

1. Automatic-manual unit
2. Remote set-point adjustment
3. Valve position indication
4. Chart re-wind mechanism (optional)

THIS tiny (4⅜ x 5") pneumatic TRANSET RECORDER for flow, liquid level, pressure and temperature, greatly simplifies the most complicated central control problems. It indicates and records in the same space required by a conventional-sized indicator alone. And it eliminates receiver wings on even the most up-to-date central control panels (particularly graphic panels).

HERE ARE A FEW UNIQUE ADVANTAGES:

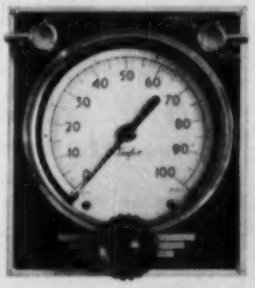
1. *Easily removable chart-drive mechanism for re-loading.*
2. *Scale shows actual transmitter process range —is graduated 3-15 psi. for checking calibration and valve position.*
3. *Automatic-to-manual feature gives easy start-up—makes it easy to service controllers.*

You Can Get These Four Models: **(1)** One process record, set-point indication, set-point adjustment, valve position indication, and automatic-to-manual unit. **(2)** One process record, valve position indication, and remote manual valve loading. **(3)** One process record only. **(4)** Transet Indicator (below).

For Complete Details, Send for Bulletin 98079. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*

TRANSET INDICATOR

Fits into the same panel cut-out as TRANSET RECORDER. Many parts interchangeable with TRANSET RECORDER. Available with or without Automatic-Manual and remote control point setting.



*Reg. Trade-Mark

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

A.W. ALGRIP
Non-slip—Even on Steep Inclines
ROLLED STEEL
Even distribution of abrasive particles shown by magnifying glass.
Prevents slipping on factory floors, walkways, etc.
Protects workmen and vehicles from slipping on ramps and loading platforms.
Write or use coupon for complete information about this amazing, new, non-slip floor plate now.

NEW ■ NEW ■ NEW ■

DEPENDABLE

VALVE OPERATION

LIMITORQUE VALVE CONTROLS

Hundreds upon hundreds of LimiTorque Valve Operators are used on Pipe Lines and in Refineries throughout the world, because they operate (at the mere "push of a button") . . . under the most severe conditions of Heat or Cold, Rain, Snow, Dust, Dirt or Fumes . . . night and day . . . year-in and year-out—LimiTorque saves time, labor and money by *eliminating* manual operation of valves at distant locations. It opens and closes valves at the exact speed required, and is *absolutely* dependable and safe. Also, as the name implies, LimiTorque limits the torque applied to valve operating parts, and thus prevents damage to stems, discs and seats, etc.

LimiTorque utilizes any available power source for operation: electricity, oil, gas, water or air. You take no chances with LimiTorque, because it has been tested and time tried under all conditions.

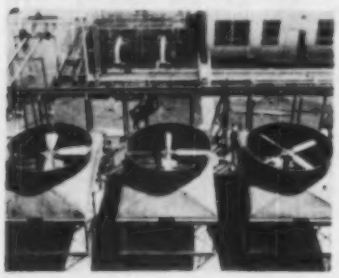
Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON
IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 283.)



uous, open air operation. The fans are also made in sizes ranging from 6 feet to 20 feet in diameter. The fan is applicable to engine jacket water coolers for natural gas, gasoline, or diesel engines; vertical air discharge condensing units; oil field and power utility air coolers and water coolers; and large air conditioning systems. Photo shows installation of three fans at an oil refinery.

Corrosion-Resistant Paint

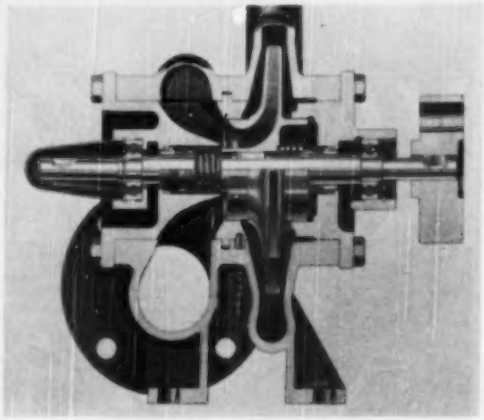
18 Bulletin 712 of The U. S. Stoneware Company tells where and how to use Tygon paint, and where not to use it. Corrosion resistant tables are based almost entirely on field experience. Chemical resistance characteristics are also listed, as are recommended primers and surface treatments.

Crotonaldehyde

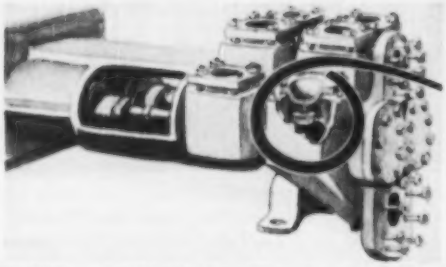
19 A Niacet Chemicals bulletin on Niacet crotonaldehyde presents its advantages over liquid sulfur dioxide as an extractive agent for removing unsaturated aliphatics or aromatics which may contain nitrogen, oxygen and sulfur in the solvent refining of crude petroleum. Also included are the physical and chemical properties, the latest specifications, and information on the shipping and handling of this chemical. Bulletin 24.

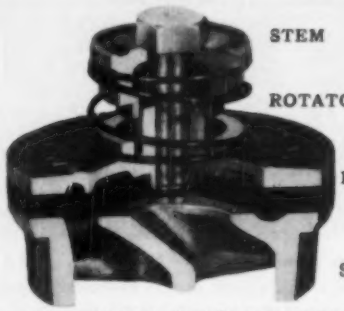
Exchange Plan Pump

20 De Laval Steam Turbine Company's Type GS pump is designed to fit the idea of a service and exchange plant. All parts except the bare pump casing are contained in the rotor assembly. For maintenance, the top cover and end plate studs are removed, the assembly lifted out, and a new one dropped in place. Through the plan, new rotors are available for immediate shipment from factory stock. The old one is returned and full credit given for all serviceable parts. Also, a customer can exchange the entire pump for a factory rebuilt and guaranteed pump, with full credit being allowed for serviceable parts. The casing is horizontally split, with all parts interchangeable and available for immediate shipment from factory stock. The pump is built in three sizes for capacities to 450 gpm., heads to 230 feet. Mechanical seals replace the stuffing box, and bearings are prelubricated for lift. Other features include pump case with cover, cast iron construction, stainless steel shaft, and bronze and cast impeller.



SIMS PUMP VALVES





Cutaway View of Sims ***Inclined*** *Port* ***Rotating*** *Pump Valve*

ARE GUARANTEED TO:

Permit a pump to INCREASE its CAPACITY. SAVE their COST within two years. PREVENT Seat-imprinting. Give you years of EFFICIENT SERVICE.

Sims Pump Valves are available for all reciprocating pumps.

Write for catalog and name of agent nearest you.

SIMS PUMP VALVE CO., INC.

145 Hudson St., New York 13, N. Y. WAlker 5-3054

M&M Building, Houston, Texas, CEntral 9704

TO FIT INTO YOUR MARKETING PLANS

Du Pont Offers...

A MOVIE THAT SELLS THE "QUALITIES" OF GOOD GASOLINES—A seventeen-minute, four-color, animated, motion picture that talks the service station man's language but tells your quality story.

AN EASILY UNDERSTOOD CARTOON BOOKLET TELLING GASOLINE QUALITY STORY—A colorful and interesting summary in cartoon form, of the film story for your imprint and distribution either at film showings or separately.

A QUARTERLY NATION-WIDE MOTOR GASOLINE SURVEY—Compiled from service station samples picked up in all major market areas. Shows motor and research octane ratings of both premium and regular fuels by individual brand (identified by code symbols so you can pick out your own). City averages are also given.

A TRAVELING FUEL TEST FLEET—Now touring the country, these specially instrumented cars graphically demonstrate to your customers what goes into making a good gasoline to insure top road performance. These cars are also available when in your area, for road tests of your fuel.

SPEAKERS AND PROGRAMS FOR DEALER EDUCATIONAL MEETINGS—Du Pont will provide speakers and will help you plan interesting and instructive programs for dealer sales and service meetings. Talks may be selected that are technical or semitechnical in nature as desired.

INSTRUCTIVE FIELD LABORATORY SESSIONS FOR MARKETING PERSONNEL—Arrangements may be made for instructive tours of the Du Pont Field Laboratories by your sales engineers or other marketing group personnel. Demonstrations and explanations of testing methods will be given them.

HELP FOR USERS OF YOUR FUELS—Analysis of fleet and bus operating difficulties by Du Pont automotive authorities—safety and medical supervision and advice on TEL handling, tank cleaning and the like in bulk plants are all available from Du Pont.

Ask your Du Pont Petroleum Chemicals representative how you can obtain these services.

USE DU PONT TETRAETHYL LEAD COMPOUNDS

DU PONT

Better Things for Better Living through Chemistry

Du Pont Provides
A Complete Line of Gasoline Additives
To Give Your Fuels Their Salable Qualities

Du Pont provides you with one dependable source from which you can obtain *all* of the additives needed to give your gasoline the qualities by which motorists will identify it.

Tetraethyl Lead Compounds, (Motor Mix and Aviation Mix) provide an economical method of securing a desired octane rating.

Antioxidants, Nos. 5, 6 and 22, provide a choice from which one can be selected for minimum cost with maximum assurance of ample storage stability.

Metal Deactivator, by controlling copper effectively, often reduces antioxidant needs sufficiently to effect a major economy and thus helps produce a better fuel at lower cost.

Dyes, in a complete range of colors, are all readily soluble in gasoline and permit the positive color identification of your fuel.

DID YOU KNOW

That Du Pont "Lucite" acrylic resin, as used in illuminated signs, is being utilized by oil companies to identify their service stations? Its ability to bend light and its ease of maintenance make a sign that is both effectively eye-catching and economical.

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
PETROLEUM CHEMICALS DIVISION
Wilmington 98, Delaware

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REG. U.S. PAT. OFF.
Better Things for Better Living
...through Chemistry

District Offices: New York, N. Y.; Chicago, Ill.; Tulsa, Okla.; Houston, Texas; Los Angeles, Calif.

District Laboratories: Wilmington, Del.; Chicago, Ill.; Tulsa, Okla.; Houston, Texas; El Monte, Calif.

A - 924

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 283.)

Hidden Arc Welding

21 A new welding process of The Lincoln Electric Company employs welding current densities on 5/64-inch electrode wire which melt the electrode at speeds comparable to using 10,000 amperes on a standard 5/16-inch diameter coated hand electrode. The new Hidensity process can be used with any standard Lincoln Electric SAE 600 or SAE 900 welding generator or an SAE 600 gasoline engine-driven generator. The process uses either a 3/32-inch or a 5/64-inch diameter electrode wire. Welding currents up to 600 amperes are used with these wires which, on the small cross sectional area of the wire, produce extremely high current densities. These high densities create a deeply penetrating arc which in turn allows the use of high welding speeds. This also means that in general little or no edge preparation of joints is required, and therefore less weld metal is used in completely fusing the joint.

Motor Preset Speed Device

22 The General Electric ACA motor (a-c adjustable-speed) is now available with a mechanical follow-up control for achieving a fixed preset speed without the use of expensive control equipment. According to company engineers, the new device enables a predetermined speed to be set manually by a knob either directly on the ACA motor or at the end of a flexible cable 10 or 15 feet away. The speed adjustment can be made while the motor is at a standstill or while it is running.

Tempilaq®

23 Tempil® Corporation announces development of additional high temperature ratings of Tempilaq® to indicate 1650, 1700, 1750, 1800, 1850, 1900 and 1950° F. Beginning with 113° F., Tempilaq® is available in 12½° steps to 400° F. and in 50° steps from 400° to 1950° F. Tempilstiks®, the crayon form of temperature indicator, and Tempil® pellets are available in similar intervals from 113° to 2000° F. Tempil® pellets can be supplied in 50° steps in the range from 2000° to 2500° F.

Air Relief Traps

24 Ball float traps for venting air from any liquid under pressure are described in Bulletin No. 206 of Armstrong Machine Works. Applications are for venting air from: hot water heating systems; water service lines; water

HAVE YOU SEEN THIS NEW BOOKLET?

Condensed information on the function, applications and resultant economies obtainable through this modern development in Entrainment Separation.

The effectiveness of METEX MIST ELIMINATORS has been demonstrated by installations of several years' standing both in this country and abroad. Used in vacuum pipe stills, scrubbing towers, knock-out drums, evaporators and similar equipment and equally adaptable to new or existing installations, they have effected such marked economies as:

1. 95% or better entrainment removal
2. End-product quality secured even with lower-cost raw materials
3. Operation at full capacity without contamination
4. Practical elimination of re-runs

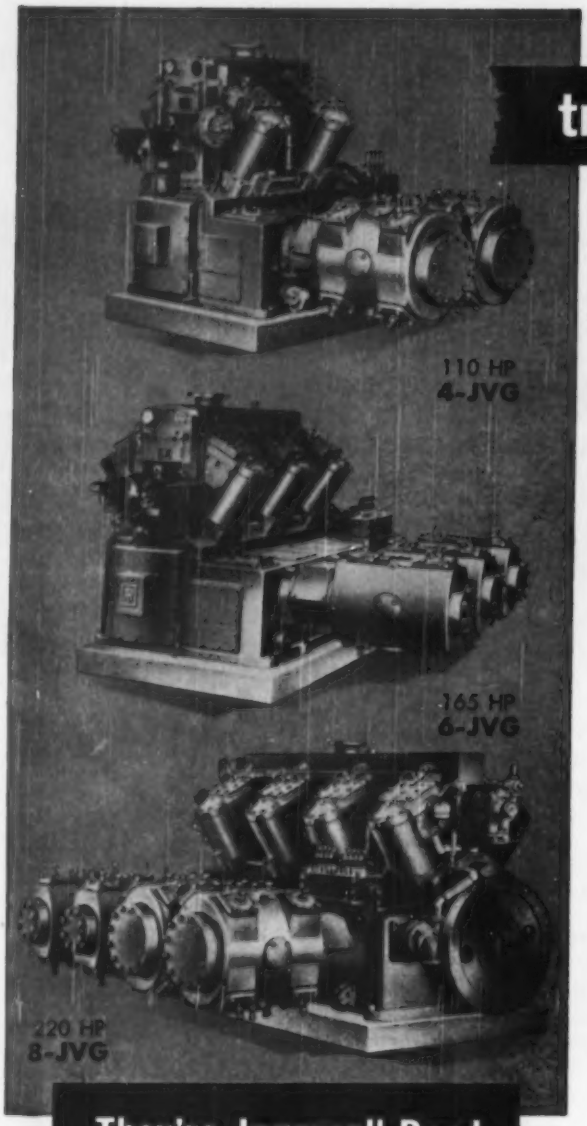
Write for your copy today. The coupon below is for your convenience. No obligation, of course.

METAL TEXTILE CORPORATION
633 EAST FIRST AVE., ROSELLE, N. J.

METEX

Metal Textile Corp.
633 East First Ave., Roselle, N. J.
I would like to have a copy of your new booklet, Metex Mist Eliminators

Name..... Title.....
Company.....
Address.....
City..... State.....



try these for size

...and economy!
...and performance!

The light-weight, gas-engine-driven JVG is now available in three sizes ... 110, 165, and 220 horsepower ... for refinery or oil field service. Excellent running balance of these Ingersoll-Rand 4-cycle V-angle compressors, needing only small foundations, makes them ideal for skid mounting and jobs where frequent relocation is necessary.

The JVG is designed for maximum flexibility of loading, to meet any pressure conditions ... any gas ... any service. Maintenance men and operators praise its heavy-duty construction, economy of fuel and lube oil, and simplicity and compactness. They also like the perfect combustion and smooth, quiet 4-cycle operation under all load and speed conditions.

These units will meet your most exacting specifications for high efficiency, conservative rating, long life and low maintenance ... whether the job be for semi-portable use or permanent installation. Consult your nearest I-R representative for complete details.

Horsepower	Width	Length	Height
110	6'-2"	8'-5"	6'-3"
165	8'-3"	8'-5"	6'-3"
220	10'-4"	8'-5"	6'-3"

They're Ingersoll-Rand
JVG
GAS-ENGINE-DRIVEN
COMPRESSORS

4 CYCLE V

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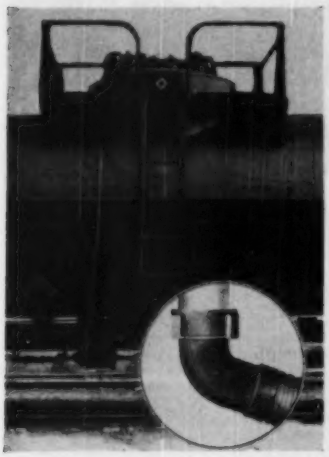
COMPRESSORS • AIR TOOLS • CONDENSERS • ROCK DRILLS • TURBO BLOWERS • CENTRIFUGAL PUMPS • OIL & GAS ENGINES

Types XVG, SVG and KVG gas-engine-driven compressors are available for installations requiring larger horsepower ratings.

storage tanks; centrifugal pumps; gasoline lines; dry cleaning solvent filters. Included are hookup diagrams, cross-sectional drawings of the traps and physical data of cast semi-steel and forged steel traps, both direct lever action and spring loaded snap-action types.

Unloading Coupling



25 A light-weight non-ferrous elbow tank car unloading coupling, developed by Atlantic Metal Hose Company, is claimed to be 66 percent lighter than the malleable iron coupling in general use. A four-inch non-ferrous coupling weighs 4¾ pounds. Other features claimed are higher tensile strength and non-sparking qualities.

Fog Nozzle

26 A new type, three-way fog nozzle that will extinguish oil, electrical, paint, and other fires with least possible water is announced by Bete Fog Nozzle, Inc. Known as the Bete G-5 fire nozzle, the new unit can be changed from full fog to straight stream to complete shut-off. A patented spiral tip and movable core "make the nozzle self-cleaning and practically non-clogging." The nozzle can be operated from 30 to 150 pounds, using at 100 pounds about 8 gpm. for fog and 10 gpm. for straight stream.

Demand Mask

27 For 30-minute respiratory protection in toxic or oxygen deficient atmospheres, Mine Safety Appliance Company has developed a new demand mask, which with oxygen or air cylinder, weighs 32 pounds. Bulletin No. B-20 contains details on the design and operation, and data on the front-type demand mask, which when carried on the wearer's chest, provides respiratory protection from 8 to 10 minutes. Both types of masks may be equipped with a speaking diaphragm permitting unrestricted verbal communication and use of telephones.

Double Hung Arch

28 Features of Geo. P. Reintjes Company's double-hung insulated arch include pendulum suspension, self-alignment, insulation, adjustable supports, ease of erection, and standardized parts.

Deep Well Turbine Pumps

29 Illustrations in The Deming Company's Bulletin No. 4700 show construction details, various types of drive and typical installations of deep well turbine pumps manufactured by firm. Pumps are furnished for wells with inside diameter of four inches or larger. Capacities vary from 12 to 3000 gallons per minute.

New Equipment

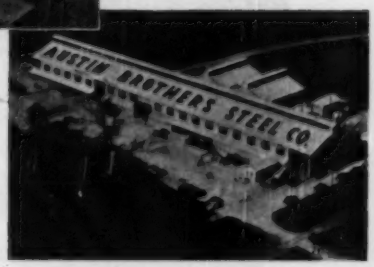
(For additional information or literature check item numbers on mailing coupon, page 283.)

Rotary Pump

30 A new, self priming, positive displacement, rotary type pump, designed to handle a variety of difficult pumping applications has been announced by the Lindquist-Reynolds Pump Company. Impellers consist of two steel spiders on which an abrasive resistant layer of neoprene, Hi-Car or Buna rubber has been effectively bonded. Drive is provided by steel-cut machine

SERVING THE INDUSTRY

FROM 2 GREAT PLANTS



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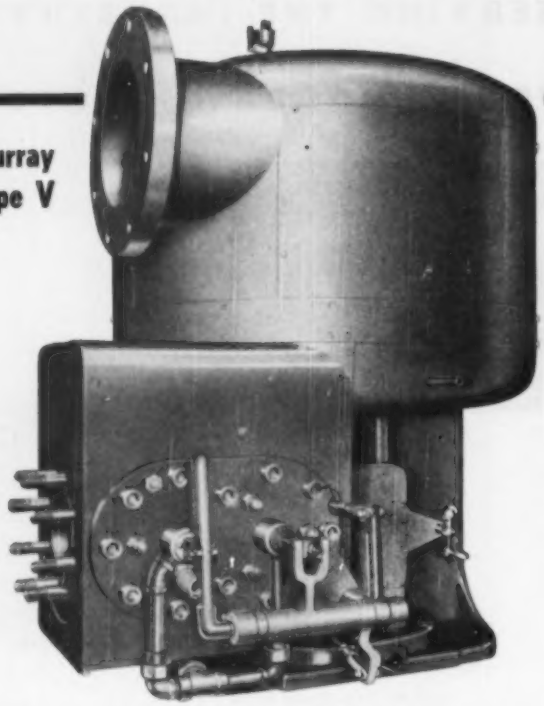
WHY NOT TURBINE DRIVE?

Pumps, fans, compressors, special processing machines, in fact almost any machine requiring driving power can be fitted with an economical and dependable steam turbine driver selected from the many types available.

Steam turbines provide safety, low maintenance expense and ability to operate for long periods without inspection. Unsheltered installations are highly practical.

A large selection of types and frame sizes, special features and accessories are available on short delivery to suit your application.

Murray Type V



Among the newest in the Murray turbine line is the Type V vertical turbine, above. This machine provides completely enclosed construction, either direct-connected or geared for vertical pumps up to 600 HP and beyond. See that your new vertical pump is driven with a Type V steam turbine.

Contact your nearest Murray representative or write direct to—

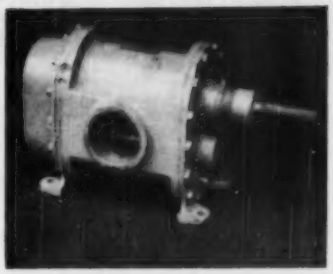
MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century.

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 283.)



gears keyed to the shaft and enclosed in an oil bath case which is isolated from the medium being pumped. The rubber affords a self priming suction lift of 20 feet and provides a resilient surface which permits the handling of viscuous liquids, slurries and solutions containing mud, sand and abrasives without the usual wear. Pumpage travels around the outer periphery of the case at low velocity. The erosive action of abrasives under pressure is thus reduced to a minimum. Two models are in production with capacities to 300 gpm. and with heads to 150 feet.

Globe Valve

31 A new 200-pound bronze globe valve with extra high lift of the disc and large flow areas above and below the seat is offered by The Wm. Powell Company. Also featured is the wide nominal pipe size opening through the seat. Renewable, regrindable cone-shaped discs and seats are of stainless steel hardened to approximately 500 Brinnell for maximum erosion resistance. Valves are available with screwed ends, and in sizes from ⅛ to 3 inches, inclusive.

Gear Coupling

32 Sier-Bath Gear & Pump Company, Inc. folder explains the seven-part construction of the gear coupling and compares it with other gear types to illustrate its size and weight advantages. A check list of advantages is also given, as are photographs and descriptions of typical installations. Also included are plan drawings and specifications for standard, mill motor, vertical shaft, spacer, and floating shaft types. Service factors for all types of equipment, and information on how to select the right coupling, are also given.

Steam Jet Syphons

33 A full line of SK steam jet syphons which operate on the jet principle utilizing the energy of steam under pressure to pump, heat, mix liquids, and handle solids is described in Bulletin 2-A of Schutte and Koerting Company. Included are de-

2 GREAT PIPE INSULATIONS

Unibestos No. 750 - to 750° F.
Unibestos No. 1200 - to 1200° F.

Available in Cylinders or Half-rounds

UNIBESTOS®

. . . single-layer application saves money

When you can insulate a pipe efficiently with only one layer of covering, you save money. The range of thicknesses in which Unibestos Pipe Insulations are made permits the economies of single-layer application. Also a distinct saving in warehousing is made possible because fewer sizes of insulation are required in stock for maintenance work. But range of insulation thicknesses for single-layer application is only one of the many features of these 2 great pipe insulations—UNIBESTOS No. 750 and No. 1200. Write today for catalog giving complete information.*

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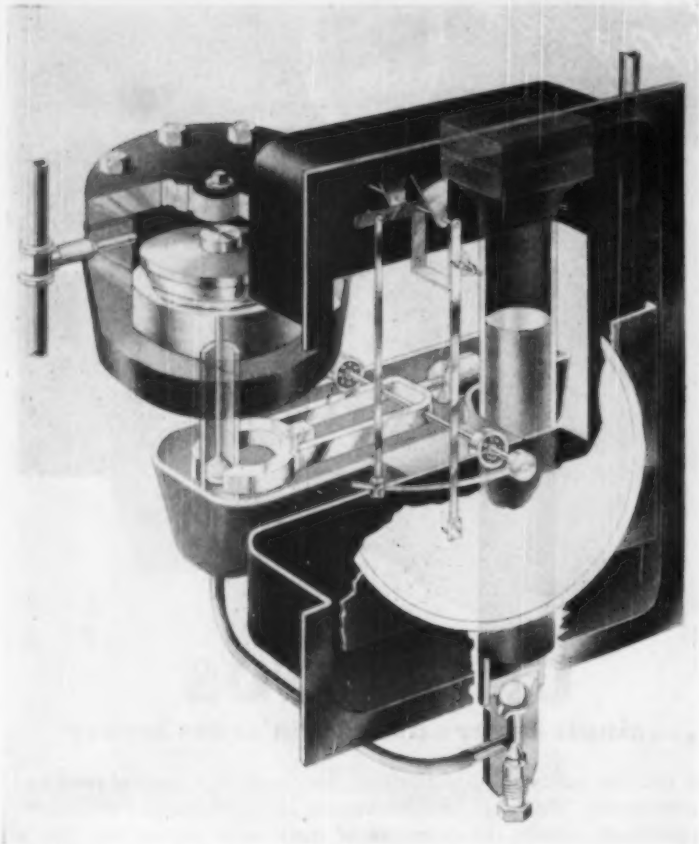
**New 8-page catalog (No. 48-1023) "UNARCO Insulations • Asbestos Packings • Gaskets • Textiles"*

HAYS-PENN MAGNA CLUTCH FLOW METERS

Suitable for working pressures up to 2500 psi

NO Stuffing Box
Torsion Tubes
Bellows
Diaphragm
Pressure-tight Bearing

therefore
NO HYSTERESIS



Highest accuracy

Maximum power provided by large float and long float travel

Minimum friction because of magnetic coupling

Ambient temperature compensation

Precise calibration check at 50%

Complete safety

No leakage possible of explosive, inflammable, or toxic fluids

Great flexibility

5 interchangeable range tubes 17 to 750″ with easy range adjustment over entire span

Lowest maintenance

Fully accessible manometer...Only one internal moving part (the float)... No bearing to service...Mercury volume and level not critical...Positive mercury check valves...Mercury easily drained.

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Bulletin 50-915

THE **HAYS** CORPORATION *MICHIGAN CITY 10, INDIANA* • Automatic Combustion Control • Boiler Panels •

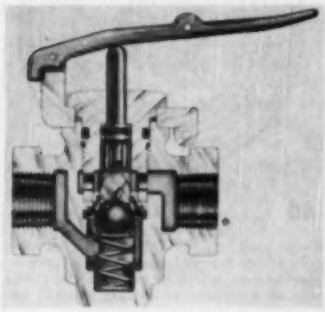
Hays-Penn Flowmeters • Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages • Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 283.)

tails on design, application, construction, operation and capacities. Special purpose and corrosion resistant syphons are covered. Applications of the steam jet syphons in the pumping, heating and mixing of liquids and the handling of solids are also included.

Controlled Flow Valve



34 For controlled flow and positive shut-off on fluid handling lines, Page Oil Tools, Inc., has designed a new valve with the stem parabolic in shape, incorporating a predetermined fixed orifice which gives a smooth, even increase in flow as the handle is actuated to open the valve. The valve closes with a positive shut-off when the handle is released. Type A incorporates an "O" ring seal around the stem in the stuffing box area, and Type B contains a chevron type ring packing.

Vertical Turbine Pumps

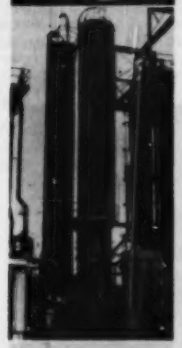
35 Capacities from 50 to 15,000 gpm. are available in a new line of vertical turbine pumps developed by Worthington Pump and Machinery Corporation. Incorporated in the line are extra size bearings of special materials for long life; shaft seals where required; enclosed impellers throughout; wearing rings; flanged and bolted bowl construction. Oil or water lubricated pumps are available from various stock locations, arranged for motor drive, right angle gear drive, or belt drive.

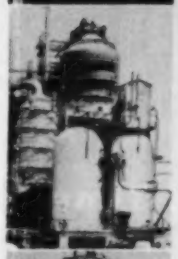
Colmonoy Nicrobraz

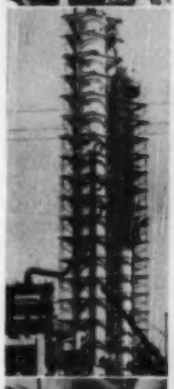
36 Nicrobraz, a heat and corrosion resistant alloy for brazing stainless steels is claimed by Wall Colmonoy Corporation to be used to braze 300 and 400 series stainless steel, Inconel, S-590, Monel, alloy steels, tool steels, carbon steels and special stainless steels. Tensile strength of a butt brazed super alloy specimen "is 120,000 psi. at room temperature, about 90 per cent that of parent metal strength; at 2000°F., the tensile strength is 99.8 per cent that of the parent metal."

Thermometer Testing Set

37 Known as the TAG-ASTM certified thermometer testing set, the unit of Tagliabue Instruments Division, Weston Electrical Instrument Corporation, comprises nine matched thermometers with overlapping ranges, available either in Centigrade (Celsius) or Fahrenheit scales. Inclusive ranges







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THE DEPENDABLE STANDARD... MODERNIZED WITH MANY ADVANTAGES FOR APPLICATOR, ENGINEER, USER

1. Lighter Weight
2. Lower Thermal Conductivity
3. Controlled Uniformity
4. Attractive Smooth Finish
5. Greater "Ductile Strength"
6. Cleaner
7. More Durable
8. Easier To Apply
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Pabco's patented process revolutionizes the natural insulation superiorities of 85% Magnesia. Specify it for your projects.

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PABCO ENGINEERING SERVICE UNITS IN ALL PRINCIPAL CITIES

New Equipment

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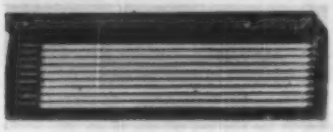

of each set are Fahrenheit, —36° up to 760°; Centigrade, —38° up to 405°. Calibrations are in 1/10, 1/5 and ½° C. and 1/5, ½ and 1° F. All thermometers are annealed, marked with individual ice points for reference, and have integral rings at the top.

Dy-Chek Method

38 Dy-Chek, the dye penetrant method of inspection for various kinds of metal, is described in a circular of Dy-Chek Company, a division of Northrop Aircraft, Inc. The chemical process is used for manufacturing inspection, receiving inspection, and preventive maintenance. Included are temperature for using Dy-Chek, supplies required, how to interpret the method, what it is, does, how it works, and when to use it.

Steam Traps

39 A new Steam Trap Bulletin issued by The C. E. Squires Company contains complete information on the Squires Steam and Air Traps as manufactured by "the originator of the upright bucket trap" including capacity tables, sizing information, blast trap attachment, double valve mechanism, etc., and also lists for the first time the Squires Venturo-Valve. Other Squires products are listed briefly.

How to Reduce
Shutdown Time
In any cooling water system there are scores of places where scale and corrosion can cause trouble and severe damage. Cleaning, maintenance and replacement of condensers, heat exchangers, coolers, piping and other equipment all represent a considerable loss, both in time and money. Losses can be reduced to a minimum, or eliminated entirely, by the proper application and control of treatment chemicals.
BETZ is an organization of engineers and chemists specializing in the solution of all industrial water problems. Over two decades of experience have made Betz water conditioning service scientifically correct, complete . . . economical. Our nationwide staff of engineers will welcome the opportunity of discussing your water problems.
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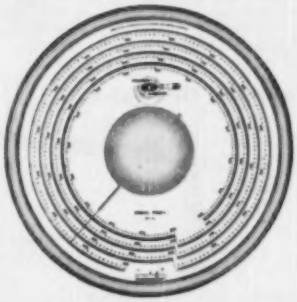
COOLING WATER CONDITIONING • BOILER WATER CONDITIONING

Aneroid Barometer



40 A micro super-sensitive aneroid barometer announced by The American Paulin System is said to be accurate to 1/1000 inch of mercury. The barometer is said to give instantaneous readings without the necessity of corrections for temperature and latitude. Model PNB-1, described, has a range extending from 24.80 inches to 31.00 inches of mercury. Other ranges available on request. All micro barometers are furnished with either wall mounting flange or russet leather carrying case for portable use.

Small Volume Air Pressure

41 "Performance Characteristics", Bulletin No. 105, of Conoflow Corporation defines the basic differences between flowing service and dead end regulation and offers suggested tests, capacity charts and other data to illustrate these statements. Equipment described are the H-10 manual loading regulator; H-15 service regulator; and FH-15 combination reducing valve and filter.

Variable Speed Drives

42 Link-Belt Company variable speed drives, available in 8 sizes and 16 types, in horsepowers of ½ to 25, with manual and automatic controls are described in Book No. 2274. Diagrams of automatic speed control applications and photographs showing a variety of PIV installations are other features. A PIV of the right specification can be selected directly from the section on preselected drives.

Self-Contained Threader

43 The Ridgid 65R self-contained threader of The Ridge Tool Company, is claimed to be jam-proof. A new design drive plate automatically kicks out the driving ratchet pawl when standard length thread is cut. Threader threads 1 to 2 inch pipe with one set of high-speed steel dies, and is said to set to pipe size in a few seconds.

Pipe Insulation

44 The wide size range of a new calcium-silicate pipe insulation, effective up to 1200° F., and manufactured by the Kaylo Division of Owens-Illinois Glass Company is illustrated by "telescope" above. Kaylo pipe

BLOOMING AGENTS
FLUORESCENT COLORS

AVIATION GASOLINE DYES

The new Petrol "ERO" Blue goes further and meets today's aviation gasoline specifications . . . also available is the original aviation gasoline dye, Petrol PC Blue, which for more than 18 years was the standby coloring agent for aviation gasolines . . . inquiries are invited for the new "ERO" Blue and for the old Petrol PC Blue for coloring aviation gasolines.

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BRONZES · AMBERS · BLUES · GREENS
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ANTHRAQUINONE DYES

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SPECIAL PRODUCTS FOR THE PETROLEUM INDUSTRY

PETROL BLUE WHITENER R and B are used to neutralize undesirable yellow shades in uncolored gasoline or kerosene.

DEBLOOMING AGENT A has the property of neutralizing blooms in lubricating oils.

N. P. A. COLOR has the property of changing body color of pale oils to red cast without affecting natural fluorescence.

GASOLINE ADDITIVES

Inhibitors for Gasoline, Oils, Rust . . . High Pressure Lubricants, Stabilizers, Emulsifiers, Detergents, Wetting Agents, Dispersing Agents.

The "PATENT" laboratories and technical staff are available for the development of special colors or for the solution of any color problem.

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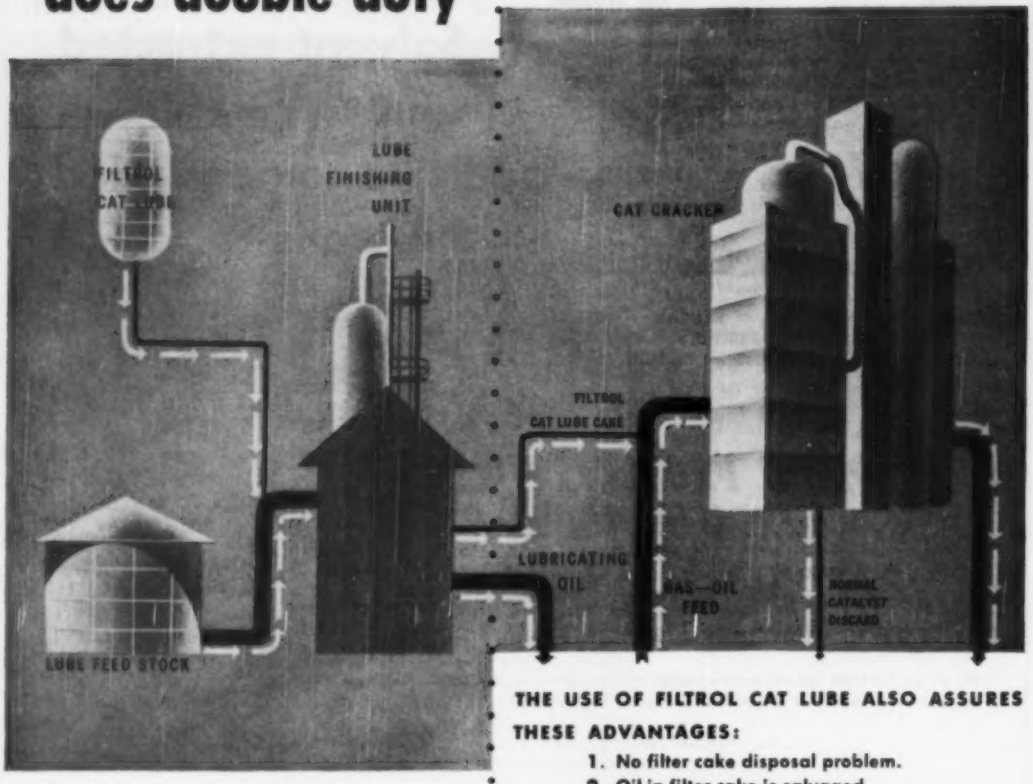
Filtrol* CAT LUBE does double duty

refines lubricating oil and then the spent adsorbent cake serves as a "fluid" cracking catalyst



THE USE OF FILTROL CAT LUBE ALSO ASSURES THESE ADVANTAGES:

1. **No filter cake disposal problem.**
2. **Oil in filter cake is salvaged.**
3. **Provides a constant supply of catalyst at practically no cost.**

An example of the successful use of Filtrol Cat Lube is the highly favorable experience of the Sinclair Refining Company which has been continuously using Filtrol Cat Lube for a year and a half with outstanding results in both lube processing and catalytic cracking.

Sinclair Refining Company was the first of many progressive refiners to take advantage of the economies made possible only through the use of "double duty" Filtrol Cat Lube.

Filtrol

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FILTROL CORPORATION

General Offices: **727 W. 7th St., Los Angeles 17, Calif.**
Plants: **Vernon, California and Jackson, Mississippi**

*T. M. Reg. U. S. Pat. Off.

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 283.)

covering is made to simplified dimensional standards which allows one piece of covering to fit over another since the outside diameter of each piece of covering is the same as that of a piece of pipe. Sizes of pipe insulation used in making the scope range from covering for ¼-inch pipe up to covering for 36-inch pipe. Kaylo pipe insulation in the ¼ to 12-inch range is made in half-sections; from 12 inches through 20 inches it is made in three sections (tri-segmental); and from 20 to 36 inches, in four sections (quad-segmental). For larger sizes, curved block is available.

Thermocouples

45 Industrial Section 22, an addition to Thermo Electric Company, Inc.'s catalog, describes industrial thermocouples. Photographs and cross sectional drawings are also given. Included are thermocouples and protection tube assemblies, wire type protected assemblies, thermocouples for plastic molding, permanent molds, power plants, chemical plants, and oil refineries, portable pouring thermocouples for molten metals, protection tubes and accessories, and connection heads, and quick coupling connectors.

Aluminum Fabrication

46 Welding Engineers, Inc. Bulletin No. 9 contains physical and chemical properties of aluminum for pressure vessels and discusses more recent developments in the practical use of aluminum for extremely low temperature applications to —3000° F. Typical aluminum fabrications, welded by the inert gas shielded arc process which produces sound welds without the use of flux, are included among the illustrations of the company's facilities for the production of aluminum vessels.

Bronze Block Gum Bath

47 Precision Scientific Company has developed the bronze block gum bath for determining the gum content of jet and diesel fuels by the air or steam jet method. Having a wide temperature range, the apparatus is equally suitable for gum testing gasolines and low boiling volatiles (ASTM D-381). The amount of gum is determined by evaporating a sample in an atmosphere of super heated steam or under a stream of preheated air. Operation is simplified by a flow gauge calibrated to indicate

GET THIS VALVE!

Accurate pressure regulation!

TYPE "C" STRONG VALVE

FOR HEATING OR PROCESS JOBS:

...with intermittent or fluctuating demand;

...requiring accurate control;

...where dependability is essential.

For positive control, use this STRONG* single-seated, pilot-controlled valve!

Simple design, extra-heavy construction make STRONG's Type "C" regulating valve give trouble-free regulation. Semi-steel for pressures to 250 psi, 450° F.; cast steel to 600 psi, 750° F. With Anum-Metl† seat and disc, this valve automatically adjusts itself to control the flow of steam, air or gas required to maintain reduced pressure.

Write us about your pressure reducing problem or request our complete steam specialties Catalog 68-R.

TYPE "O" Direct operated. Semi-steel construction suitable for initial pressures to 225 psi, 400° F. For steam, air, water or gas.

Features internal strainer, Anum-Metl† seat and disc. Direct operated, of extra heavy semi-steel, this valve is suitable for pressures to 225 psi, 400° F. TYPE "K"

*Trade Mark Reg. U. S. Pat. Off.

STRONG, CARLISLE & HAMMOND COMPANY

1392 WEST 3rd Street
Cleveland 13, Ohio

†Anum-Metl Reg. Trade Mark

OTHER STRONG STEAM SPECIALTIES

No. 070 Small Trap | "SY" Strainer | 800 Series Steel Trap

STRONG

When you're looking for

LEAD PIPE

to keep corrosive chemicals in line

The chemical industry relies on lead pipe to convey corrosive materials.

It relies on National Lead to supply this pipe in the proper form and alloy for each specific application.

National supplies lead pipe in several grades and types as well as in all weights and sizes.

The grades include chemical, antimonial, tellurium, tellurium-antimonial. And the new Nalco Metal for chromium platers. All are made from "St. Joe chemical lead."

For installations requiring extra structural strength, National makes "United" and "United Tubond" lead-lined pipe and fittings. Both combine the corrosion resistance of lead with the strength of steel. All linings are seamless, smooth bore, and of uniform wall thickness.

When you buy lead pipe, specify National—and take advantage of metal resources, mechanical equipment, and production facilities that are unmatched. National has manufacturing plants in all principal cities.

...look to the Leader in Lead

...in everything from lead pipe... valves... sheet... and lead-lined or lead-covered equipment...to complete acid recovery plants.

NATIONAL

LEAD COMPANY

New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 8; Cincinnati 3; Cleveland 13; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Company of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Co. Ltd.).

Trademarks
Reg. U. S. Pat. Off.

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 283.)

the air flow in liters per second. The five-unit bath has a temperature range from 300° F. to 600° F. which is automatically controlled to ±5° F. Three inches of glass wool insulate sides and bottom. Top insulation is electrobestos. The circular housing is heavy gauge, polished stainless steel. Over-all dimensions are 19 inches in diameter and 15½ inches high.

Speed Reducers

48 The concentric shaft speed reducer, Type C, and the horizontal or vertical right angle speed reducer, Type CB of The Falk Corporation, are adaptable to electric motor drives, belt drives, gas engine, drives and chain drives. Bulletin 1105 contains method of selection, h.p. rating tables, torque capacity tables; minimum sprocket diameters, maximum overhung loads, weights, oil capacities, order guide, and dimensions.

Cloud and Pour Test Cabinets

49 King Refrigeration Company is featuring in its line of laboratory refrigeration equipment separate refrigeration unit and coils for each temperature, plus four models of cloud and pourtest cabinets which are described in a company bulletin. Two of the models are for requirements of a minus 60° F., one for plus 30° F. and another, a complete test in one unit. Sleeves, over-all dimensions, and other data are given.

Boiler Feedwater Control

50 Boiler feedwater control is explained in Bulletin No. S-52 of Republic Flow Meters Company. A comparison of the three systems and the advantages of each are featured in this eight-page brochure.

Ball Valve

51 W-K-M Company announces a new valve for general duty, the Venturiball valve, especially designed for throttling applications in high pressure, corrosive or erosive applications. It features straight line discharge characteristics. In the throttling position, the ball presents a smooth surface, with non-turbulent flow possible over a wide range without destruc-

fifty ton H_2SO_4 plant

inside and outside

clean—efficient—and compact complete chemical plants . . .

When you intend modernizing, expanding, or building an acid plant or other chemical facilities—of any size—anywhere—it will be worth your while to investigate the type of services being rendered by our organization. We furnish all required equipment and materials *COMPLETE*—engineering, drafting, construction, supervision of operations, training of operating personnel, consultations, and periodic inspections. Write today for details. No obligation.

NICOLAY TITLESTAD CORPORATION

11 West 42nd Street New York 18, N. Y.

Special technique assures quality of Kellogg "knock-down" vessels

ONE of the frequent causes of high cost in the field-construction of large refinery vessels does not really start in the field at all. Actually it occurs in the shop-fabrication of these "knocked-down" vessels.

Mis-alignment is the field man's bogey . . . mis-alignment, not only between segments of any one course of a vessel but also between the different courses themselves.

To preclude the possibility of saddling any constructor's field crews with the costly field correction of "misfits," Kellogg shops follow a special routine developed from both *shop and field* experience.

In effect Kellogg completely "builds" even the largest vessels right in the shop. Beyond matching individual segments to master templates, each successive course of every vessel is superimposed on the previously assembled course. "Knocked-down" vessels built in this manner for the field can't help but fit.

Such accuracy in fabrication has brought wide recognition of Kellogg quality in all types of vessels. It gives assurance of exact tray positioning and leveling and of close tolerances in nozzle positioning. It's another reason why Kellogg vessels—completely shop-built or shop built in "Knock-down" form—achieve high operating efficiencies and low maintenance records.

Illustrated—Alloy clad 23' diameter reactor being "knock-down" fabricated in Kellogg shops.

To master temperature and pressure use

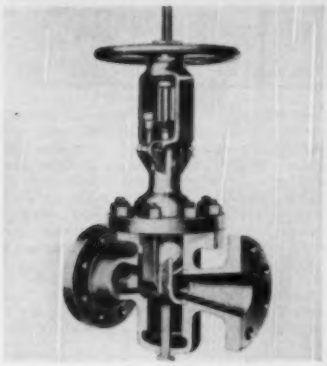
M. W. KELLOGG

piping and process equipment

The M. W. Kellogg Company, Inc. (A Subsidiary of Pullman Incorporated)—Offices and Plants—New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London

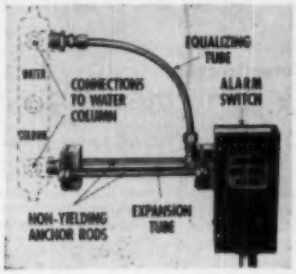
New Equipment

(For additional information or literature check item numbers on mailing coupon, page 283.)



tive erosion or wire drawing. Line contact between ball and seat assures tight, absolute shut-off. The ball seats in a different position each time, distributing wear over its entire surface. There are two seats and the valve may be reversed in the line. Bulletin No. 695.

Boiler Alarm



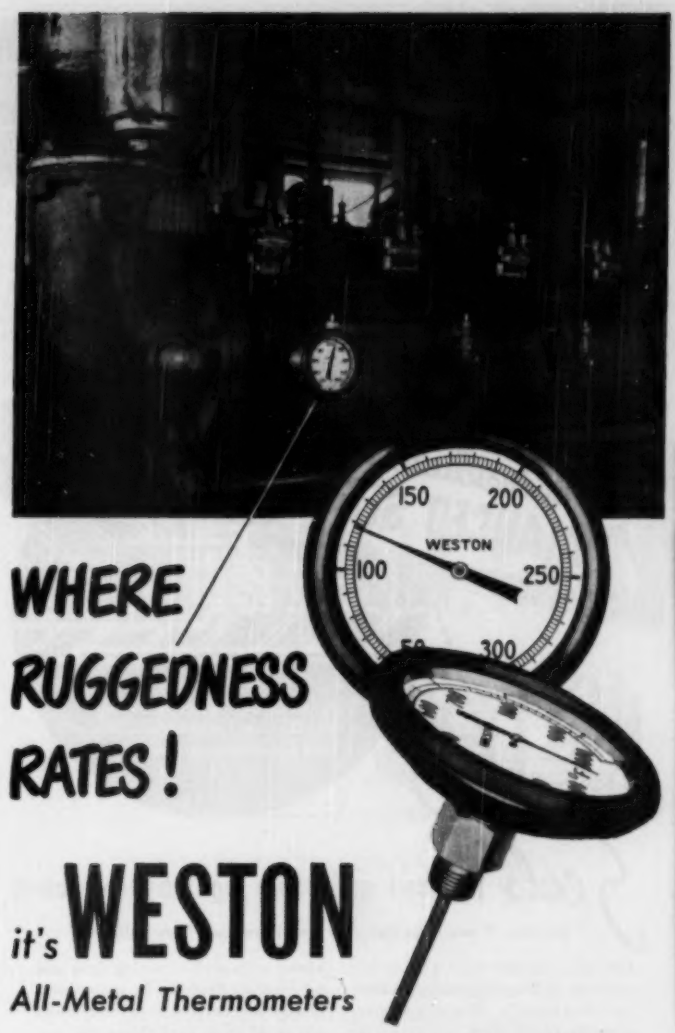
52 A super-sensitive device for boilers to sound an alarm for low water level, the Micro Thermal low-level boiler alarm, is manufactured by J. A. Campbell Company. It can be attached to any boiler water column by use of the flexible tube and connected to a single 6-volt dry cell battery. The switch works on .001 inch pin throw. The mechanical advantage on the lever is ten, so the switch throws on an expansion of .0001 inch. The switch will throw on and off on a temperature change of 5° F.

Stud Welding

53 "Stud Welding," a reprinted chapter of the third edition of Welding Handbook, published by American Welding Society, explains the stud welding method of fastening, describes the equipment and its principal uses, and gives stud locating procedures and other data.

Chem Construction Materials

54 The Atlas Mineral Products Company announces General Bulletin MCC No. 1 describing the complete line of chemical construction materials including corrosion-proof linings,



WHERE RUGGEDNESS RATES!

it's WESTON

All-Metal Thermometers

Where the going is tough, WESTON thermometers get first call. Their rugged construction—all-metal throughout—enables them to stand up on pumps, compressors and mobile units. And the big, bold dials are easy to read—quickly and accurately! There are many types, stem lengths and scale ranges from which to choose. Ask your jobber or local WESTON representative, or write for Thermometer Bulletin. WESTON Electrical Instrument Corporation, 655 Frelinghuysen Avenue, Newark 5, New Jersey.

CONTACT-MAKING models for alarm or control purposes. MAX-MIN models to indicate highest or lowest temperature reached.

WESTON Instruments

New Equipment

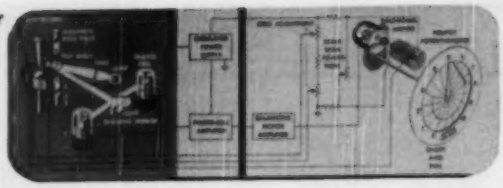
(For additional information or literature check item numbers on mailing coupon, page 283.)

corrosion-proof cements, acid-proof brick and tile, corrosion-proof brick sheathings, corrosion-proof protective coatings and corrosion-proof floors. Estimating data is also included.

Solving Pumping Problems

55 "Layne Short Coupled Service Pumps", issued by Layne & Bowler, Inc. contains cut-away drawings of pump bowls and discharge column. Sixteen sketches show the Layne vertical turbine pump applied to river and relift service, boosting, recirculation, cooling tower, drainage, gas and oil pumping, and fire pumps.

Oxygen Analyzer



56 Operating principle of A. O. Beckman, Inc.'s oxygen analyzer consists of a light dumbbell-shaped element made of two small hollow glass spheres supported on a quartz fiber. Measurement is based on fact that oxygen is strongly paramagnetic. The glass spheres are free to rotate in a non-uniform permanent magnetic field and are subjected to a magnetic force which is proportional to the difference between the volume magnetic susceptibility of the glass spheres and the gas which the glass spheres displace. Simple electrical circuits in the analyzer, enable features such as standardization, multi-ranges, high sensitivity and accuracy, remote indication and control. Range of low oxygen concentrations are available in a maximum sensitivity of 0-200 parts oxygen per million, with higher oxygen concentrations instruments supplied in a concentration range with minimum scale span of 1 percent oxygen. Readings are accurate to within ±1 percent of the scale span for all standard ranges of 0-5 percent and greater, and to ±0.02 percent O_2 for 1 percent scale span at any concentration.

Couplings

57 A new complete line of fire hose couplings and fire hose coupling accessories is announced by Hose Accessories Company. Le-Hi line of fire hose coupling includes satin finish pin lug and Glider lug coupling in a complete range of sizes and types for chemical, linen, mill and fire department hose. Bulletin No. 7 describes the new line and contains thread data on all standard U. S. hose soupling threads.

Water Treating

58 Industrial water problems of all kinds — procurement, treatment, usage and disposal—and the facilities and services offered in coping with them are described in a booklet, "Your Most Important Raw Material," published by Hall Laboratories, Inc., water-consultant firm. Various kinds of industrial water problems, and their solution, are described.

Steel Filters

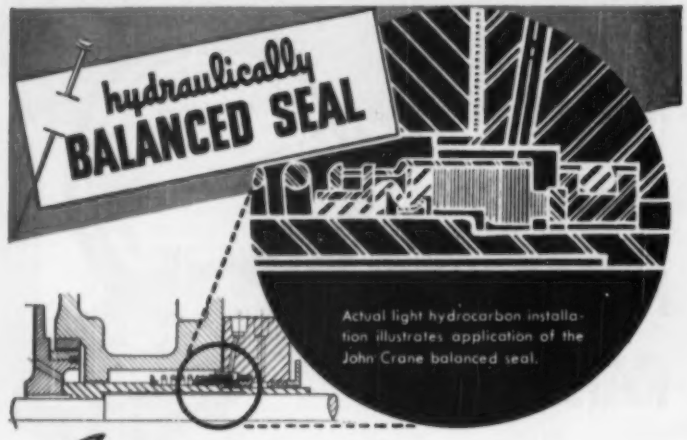
59 Advantages, uses, operation and manufacturing methods of Surfamax filters of Micro Metallic Corporation are given in a company bulletin. A listing is given on the properties, water flow and air flow of these porous stainless steel filters. Selection data are also included.

Phenol

60 The chemical division of Koppers Company, Inc. has issued Bulletin C-O-115 describing the physical and chemical properties, uses, and chemical reactions of Di-tert-Butyl-para-Cresol (DBPC). DBPC is a crystalline, tri-alkylated, hindered phenol which is insoluble in water and aqueous alkali of any strength. Also included is a bibliography of scientific references.

Continuous Blow-Off Valve

61 A continuous boiler blow-off valve that removes highly concentrated impurities from 4 to 6 in. below the water surface at the same rate they are introduced is announced by Uniblow Valve Company. Valve has no moving


hydraulically
BALANCED SEAL
Actual light hydrocarbon installation illustrates application of the John Crane balanced seal.

Seals propane and other light hydrocarbons

"Service-Proven" on Refinery and Pipe Line Installations

The "John Crane" Type 1 Shaft Seal will mean outstanding sealing performance on practically all your petroleum services, *including the effective sealing of Butane, Propane and other light hydrocarbons.*

This seal is being widely used today for all general petroleum services—is suitable even for pressures to 500 psi.

It is a single unit and requires no auxiliary lubricating system. Proper balancing of sealing faces, and the selection of proper face widths for each job insure leak-proof operation.

Based on our wide refinery and oil field experience, we usually recommend the single balanced seal, as shown above, with perfect mating faces and with enough flexibility to allow plenty of axial and radial movement. Numerous installations have shown that any pump in good working order, using reasonably clean fluid, can be successfully equipped with this seal.

Proof of its unequaled service is found in its use by many major refineries. Practically all leading pump manufacturers, too, agree that this seal is the best means for sealing hydrocarbons. Most manufacturers furnish it as standard equipment.

Stocks of seals and packings are carried in our offices listed below. Our engineers in 32 branches are on hand to look after your service requirements.

JOHN CRANE

CRANE PACKING COMPANY

Houston: 6626 Supply Row, Houston 11, Texas
Chicago: 1820 Cuyler Ave., Chicago 13, Ill.
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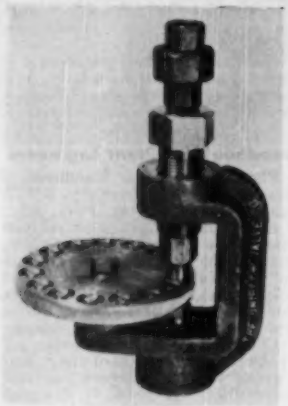
New Equipment

(For additional information or literature check item numbers on mailing coupon, page 283.)



parts or intermittent manual blow-off. The indexing control disc of hardened stainless steel is regulated to provide constant blow-off measured in pounds of water per hour, with each of the 15 orifices indexed and numbered to correspond to a flow chart provided with the unit. The entire unit is 42 by 11 by 4 inches and weighs 40 pounds. Water samples may be taken from a ½-inch cock located on the velocity reducing chamber.

Conveying Systems

62 Bulletin No. 103 of Convair Corporation describes pneumatic conveying systems for all industries. Schematic drawings show applications. Also included are installation and engineering data, materials handled, and operation principle.

Falcon-Greenwood Valves

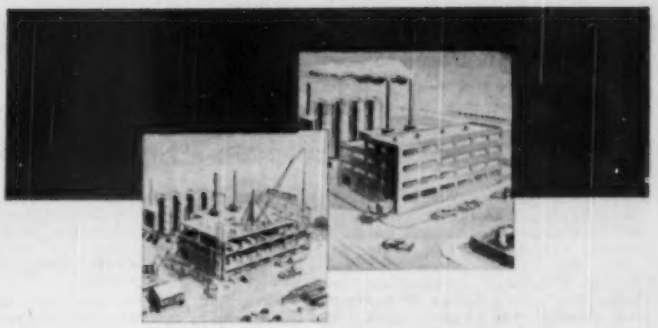
63 Falcon Products, Inc. Catalog No. 108 contains specifications and installation recommendations. Included are current models of valves; the vertical swing check, the triple action safety quick closing and the combination check and plug valve.

Flow Meters

64 Flow measurement problems and their solution are explained in Data Book No. 702 of Republic Flow Meters Company. Also included are meter bodies, differential devices, and reading instruments. A section describes wide and reverse flow.

Correction

It was incorrectly reported in the New Equipment, Manufacturers' Literature section of the July REFINER, page 198, that "16-25-6," a heat-resistant super-alloy, is produced by The Timken Roller Bearing Company under licensing arrangement with Lebanon Steel Foundry. The alloy is produced by Lebanon under license from Timken. Applications are for rotor wheels for turbo-superchargers, jet engine and gas turbines.



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BOOKS of Current Interest

Steel Castings Handbook

Steel Castings Handbook, Steel Founders' Society of America, 920 Midland Building, Cleveland 15, Ohio. Price, $4.

This 1950 revised edition of "Steel Castings Handbook" emphasizes the classes and industrial uses of the castings, contains 440 photographs and sketches, and 120 tables. Other sections discuss pattern equipment, melting practice, molding and coremaking, finishing operations, inspection, and heat treating facilities and operations, the latter including principles of heat treatment, transformation diagrams and hardenability, liquid quenching, and recommended practices for heat treatment of carbon and low alloy steels.

Remaining chapters deal with variables affecting the mechanical properties of steel castings; mechanical properties of carbon cast steels, with separate discussion of mechanical properties of the low carbon, medium carbon and high carbon cast steels; and similar separate delineation of the properties of the low alloy cast steels, including properties of various low alloy cast steels as related to certain composition types, and alloy steel castings for pressure containing parts suitable for high temperature service.

Other topics include engineering properties, chemical compositions, recommendations to purchasers, definitions of foundry terms, and specifications.

Handbook for Plant Engineers

Plant Engineering Handbook, McGraw Hill Book Company, 327 West 42nd Street, New York. Price, $15.

Essentials of good plant engineering practices in 77 major areas of plant operation and maintenance are discussed in "Plant Engineering Handbook," which tells how to manage, operate and maintain industrial plants. Tables, formulae, and graphs accompany each subject.

Compiled by William Staniar, editor-in-chief, and 86 contributing authors from 46 industrial corporations and six universities, the book is designed to meet the needs of plant managers, plant superintendents, plant engineers, and plant maintenance engineers.

Discussed are the industry's consumption and conservation of basic resources, with management engineering, industrial construction, fire protection, maintenance, with industrial power and its uses, with air handling, materials handling, and the handling of services. Specialized subjects of instrumentation, bearings and lubrication, engineering materials and mechanical power also are presented, plus many others that are vital to efficient industrial and institutional operations.

Water Treatment and Analysis

Betz Handbook of Industrial Water Conditioning, W. H. & L. D. Betz, Gillingham and Worth Streets, Philadelphia 24. $2 each.

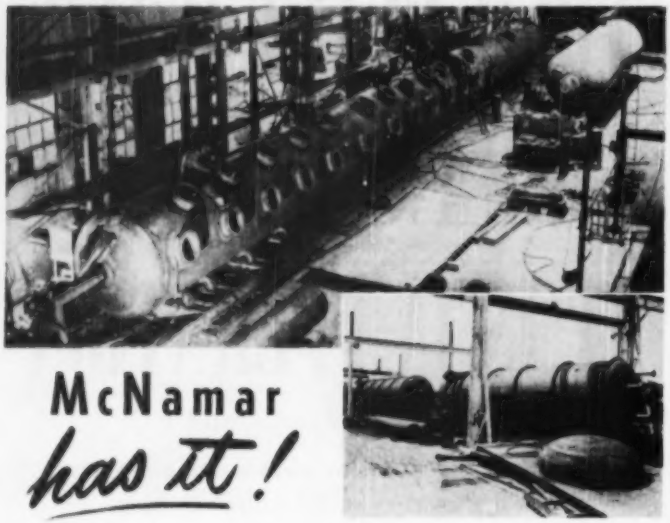
The third edition of Betz's handbook of industrial water conditioning is divided into discussions of water treatment and water analysis. The first handbook was written in 1942, the second in 1945. This latest edition describes the chemical and mechanical processes available for the treatment of water for industrial use. Where applicable, each chapter is divided into: definition of process, use of purpose, chemistry involved, mechanical equipment involved, and applications and limitations of each process.

The water analysis section deals with the impurities in water, each chapter discussing impurities, how they originate in the water, and how they can be controlled. Methods of analyses suitable for plant control are discussed in detail.

Oil and Engine Lubrication

Motor Oil and Engine Lubrication, Carl W. Georgi, Reinhold Publishing Corporation, 330 West Forty-Second Street, New York. Price $8.50.

The practical problems of engine usage, maintenance and lubrication, as well as causes and remedies affecting operating troubles, are described in Georgi's "Motor Oil and Engine Lubrication." It has been designed and written primarily as a reference work for lubrication en-



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When it comes to

STAINLESS STEEL

Fabrication . . . . .

Yes, McNamar has all the qualifications in stainless steel to give you top quality precision fabrication, regardless of the size or type of job. Whether your requirements call for stainless steel lined, stainless steel clad, solid stainless, monel, or inconel — you can depend on McNamar's "know how" and workmanship to turn out the job smoothly and accurately. Phone 2-6293 in Tulsa or write for complete information about our unlimited facilities.

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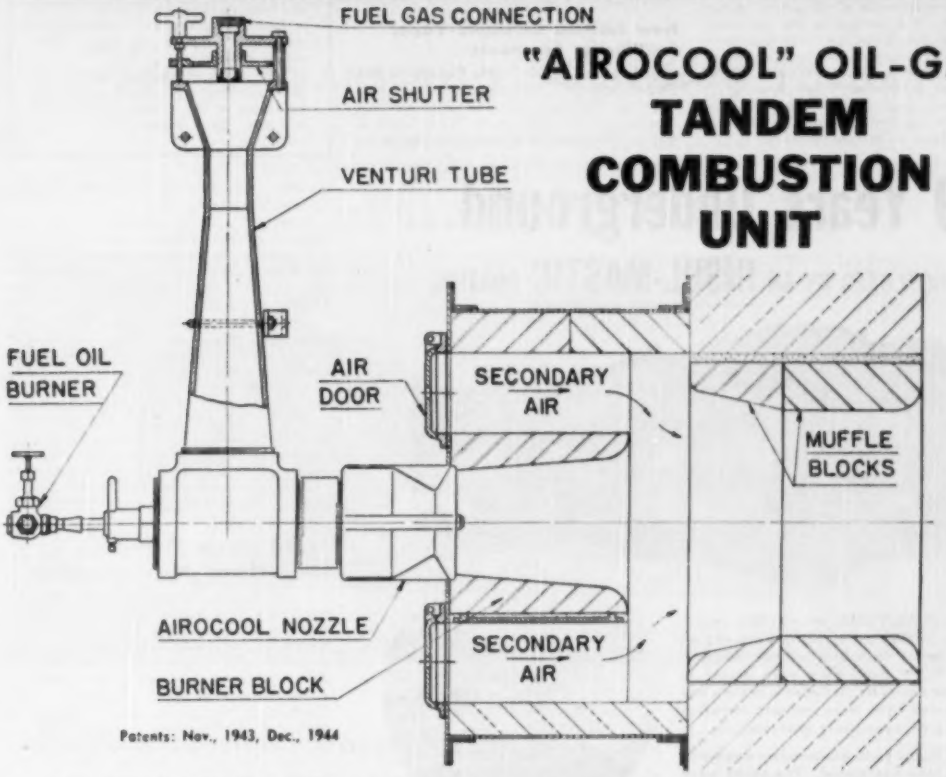
throughout the petroleum industry...



"AIROCOOL" OIL-GAS TANDEM COMBUSTION UNIT

Patents: Nov., 1943, Dec., 1944

The NATIONAL AIROIL Tandem Combustion Unit is an improved method of burning either oil or gas separately or in combination, wherein two refractory throats are used. These throats are arranged one in front of the other on the same centerline, hence the name Tandem Combustion Units.

The first throat or burner block is somewhat smaller in bore than the second throat or muffle block. The difference in block sizes allows space for rectangular air passages over and under the burner block. Through these passages secondary combustion air is admitted into the second throat or muffle block. This flow of secondary air may be adjusted, by means of doors, from theoretical to any excess, depending upon the heat distribution requirements of the convection section.

By regulating the proportion of the total secondary air entering through the top and bottom air openings, a flame pattern exactly meeting the requirements of the furnace can be created. The Tandem Combustion Unit does not produce the shortest flame, nor the longest flame, but it does produce precisely the proper pattern of flame for the furnace fired.

It is this formation of flame, exactly suited to the furnace, that at once distinguishes the heater equipped with Tandem Combustion Units as a heater which has more barrels throughput per day, more days per run, and more products per fuel dollar.

We will be glad to comply with your request for further information on the Tandem Combustion Unit and the various types available.

NATIONAL AIROIL BURNER CO., INC.

Main Offices & Factory: 1254 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PA.
Southwestern Div: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

Books

gineers, automotive service engineers, oil salesmen, engine designers, fleet maintenance superintendents, field service engineers, technical service and sales service departments of oil companies and employes in oil laboratories.

The book covers the methods of design and evaluating performance characteristics of motor oils. Particular emphasis is laid upon viscosity index and its importance in all phases of motor lubrication. One feature is the inclusion of detailed specifications covering various types of engine tests, properties of lubricants (ash, carbon residue, pour point, color, corrosion, flash point, etc.) and all types of performance ratings. Many illustrations are used, especially those relating to engine wear.

Also included are chapters on the refining and manufacture of motor oils and descriptions of their chemical and physical properties, application of motor oils and the relation of oils and lubrication to engine design, operation, maintenance and breakdowns and failures. The subject matter is arranged to permit ready reference to many types and varieties of engine failures and operating difficulties, together with causes and remedies. Other data help diagnose engine ailments and gives corrective steps necessary to prevent their recurrence.

New Editions on Liquid-Vapor Equilibrium Constants

Charts on Liquid-Vapor Constants and Fugacities, two volumes, Chemical Engineering Division, The M. W. Kellogg Company, 225 Broadway, New York 7. Prices: Volume of charts covering pressures from 14.7 to 1000 psia., $20; volume of fugacity charts, $10.

One new edition combining two volumes of charts on liquid-vapor constants, and another covering fugacities for light hydrocarbons in mixtures having charts based on the Kellogg equation of state. Differing from previous similar charts these graphs are functions of temperature and pressure as well as function of the composition of both the liquid and vapor phases. Covered are pressures graduated from atmospheric to 1000 psia. for any mixture of hydrocarbons from methane to n-heptane, including unsaturates. For higher pressures there are fugacity charts ranging from 1000 to 3600 psia. Instructions for use and sample calculations for bubble points, dew points and equilibrium flash points are included.

Reprint Policy

A change has been made in PETROLEUM REFINER's policy with regard to small, individual orders for reprints of its articles. Since January 1 a charge of 50 cents per copy has been made WHEN REPRINTS ARE AVAILABLE. This will continue.

The charge for tear sheets of a particular article, effective April 1, has been reduced to 25 cents.

Cash or company requisitions should accompany all such individual orders.

This change does not affect the price for quantity orders of reprints (starting at 100 copies) which will be quoted upon request.

19 Years Underground...

PROTECTED BY AN INSUL-MASTIC COATING

After being buried for nineteen years, these 10,000 gallon tanks were dug up and moved to a new location where—still fit for duty—they were placed in service again. An Insul-Mastic coating had protected them from rust and corrosion during all those years underground.

The Chicago Testing Laboratory examined the tanks and stated, "The tanks were found to be in an excellent state of preservation with the protective coating still intact. It is very evident from a critical examination of these tanks that the protective coating on them would have continued to function for many additional years."

During these nineteen years Insul-Mastic coatings have been improved, and are today superior to those used on the tanks depicted. Protective coatings that render such service warrant your investigation, regardless of the nature of your protection problems. Consult us at no obligation.

Waterfilled hole where tanks once rested shows poor drainage of dump ground, once swampland.

Insul-Mastic Corporation
OF AMERICA
OLIVER BUILDING • PITTSBURGH 22, PENNSYLVANIA

TEMA Elects Officers And Elects New Member

C. H. Currier was last month elected president of Tubular Exchanger Manufacturing Association, Inc., and W. C. Beekley, vice president. Named as a new member was Engineers & Fabricators, Inc., Houston. Currier is president of Ross Heater & Mfg. Company, Inc., Buffalo, N. Y., a division of American Radiator & Standard Sanitary Corporation. Beekley is president of Whitlock Manufacturing Company, Hartford, Conn.

Others comprising the new executive committee are T. H. Miley, Foster Wheeler Corporation, New York; and G. A. Worn, The Lummus Company, New York.

TEMA is an association of tubular exchanger manufacturers, formed several years ago for the purpose of establishing and maintaining high standards in the design, fabrication and performance of shell and tube heat transfer equipment. Permanent offices are at 53 Park Place, New York 7.

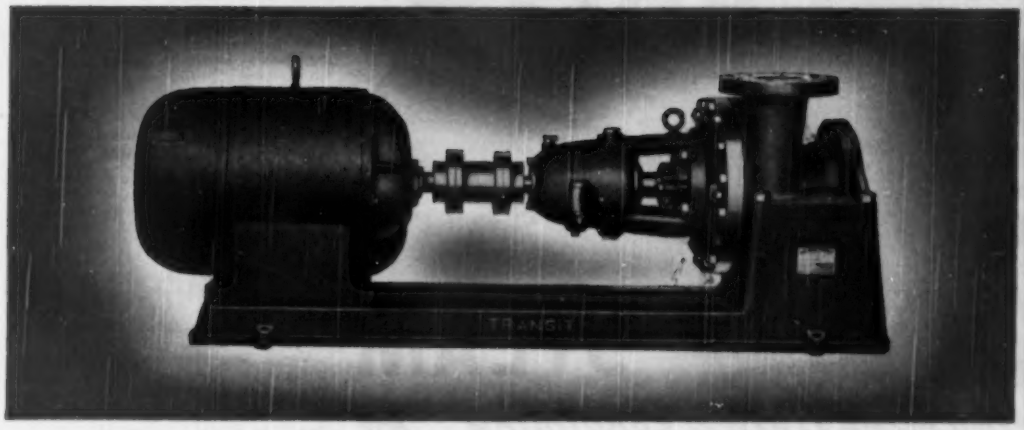
1951 Chemical Conference

An exposition of modern laboratory equipment will be a feature of the 1951 Pittsburgh conference on analytical chemistry and applied spectroscopy to be held in Pittsburgh February 28-March 2. The conference is jointly sponsored by the analytical chemistry group of the Pittsburgh section of the American Chemical Society and the Spectroscopy Society of Pittsburgh.

TRANSIT TYPE *ES* PROCESS CENTRIFUGALS

New 3 YEARS AGO - *Leading* TO-DAY

In toughest Refinery Services up to 900°F. and 500 psi suction pressures.
82% of the original buyers have now placed additional orders



Because they feature:

Lowest NPSH required with Impeller eye areas 15% larger and streamlined eye entrance.
Extra corrosion allowance and **smoother operation** with 3/16" greater case thickness.
Flatter performance curve for maximum operating efficiency over the capacity range.
Broadest range of head and capacity with the **highest interchangeability of parts.**
Latest developments in Mechanical Seal Design for higher dependability and simplicity.
Smoother running due to streamlining of impeller and volute and heavier bearing bracket.
Lowest maintenance. Parts subject to wear can be replaced in less time than in similar pumps.
Very latest proven design features of streamlined flow and mechanics which give greater dependability, lower maintenance and efficient operation at no higher cost.

Ask for Bulletin 6000.

For lower pressures, capacities and temperatures, ask for Bulletin 6100, Transit Type CS.

NATIONAL TRANSIT PUMP AND MACHINE CO.
Home Office and Works, OIL CITY, PENNA.
CHICAGO, 654 South Michigan Ave. • CLEVELAND, 702 Marshall Building • HOUSTON, Room 522 West Building • NEW YORK, 30 Rockefeller Plaza • PHILADELPHIA, 2324 Packard Philco Steel Building PITTSBURGH, 912 Farmers Bank Building • TULSA, 315 East Archer • LOS ANGELES, 2002 East 37th Street

About EQUIPMENT and SERVICE Suppliers

Fills Diamond Alkali Post

J. A. Flobeck, formerly sales manager of Sessions-Gifford Company, Inc., chemical distributors in Providence, R. I., has joined the New York-New England branch office staff of Diamond Alkali Company at New York in a special sales capacity.

Allegheny Ludlum Appoints

Roger S. Ahlbrandt has been appointed to the newly created position of manager of stainless steel bar sales of Allegheny Ludlum Steel Corporation. Ahlbrandt was formerly assistant manager, cutting tool sales.

J. R. Leheny, who replaces Ahlbrandt, is succeeded by Guy M. Winton of the San Francisco office. Leheny was before sales manager at the San Francisco district office. He has been with the company since 1933.

Food Machinery and Chemical Names New Vice President

Food Machinery and Chemical Corporation, San Jose, Calif., has elected Gerald F. Twist a vice president. Twist became associated with FMC in 1930 immediately after graduation from Stanford University where he majored in mechanical engineering. At present he is manager of the Peerless pump division with major plants located in Los Angeles and Indianapolis.

Twist

Twist later joined Atlas Imperial Diesel Engine Company of Oakland, Calif. where he was executive vice president and a director. In 1947 he rejoined FMC heading the company's newly acquired subsidiary Stokes and Smith Company of Philadelphia.

Hamilton Merrill Named New President of MMM

Hamilton Merrill, a vice president and director of Manning, Maxwell & Moore, Inc., New York, has been elected president of the company succeeding Robert Ross Wason, who died July 7, 1950.

Merrill became associated with MM&M in 1920 and was made a vice president in 1937 and a director in 1949. He has been vice president in charge of the Consolidated-Ashcroft-Hancock Division of the company since May.

Merrill is a graduate of Massachusetts Institute of Technology and a Chemical Warfare Services veteran of World War I.

Drew to Hold Industrial Water Treatment Courses

A "Water Course" on industrial water treatment will be given by E. F. Drew & Company, Inc., October 17 and 24 in Los Angeles and October 19 and 26 in San Francisco. Dr. R. C. Ulmer, technical director, power chemicals division, will conduct the course which consists of a series of lecture and discussion meetings covering fundamentals of water chemistry; industrial water problems; plant problems such as steam and condensate lines, heat transfer equipment, service water lines, air conditioning equipment, evaporators, and the interpretation of water tests.

Sales Manager Is Named By GE Plastics Division

Willard R. Barrett, has been named sales manager for the Plastics Division of General Electric Company. Formerly he was vice president and general manager of Hoosier Cardinal Corporation, Evansville, Ind. Barrett has been associated with E. I. du Pont de Nemours & Company, Inc. for 24 years serving with the experimental station at Wilmington, Del., the Philadelphia plant laboratory, and as plant manager at Chicago, Flint,

The Hose With a Reputation...for Outstanding Safety and Durability

From 30 years of hose-making experience, Goodall has built into "INFERNO" the high factor of safety and the qualities insuring extra long service life that make this hose so desirable and economical for every refinery steam service.

The tube offers remarkable resistance to hardening and cracking under high temperatures. Tightly braided galvanized steel wires reinforce the rugged, heat-resistant carcass. The tough red cover withstands severest abrasive wear and all conditions of weather.

Recommended for pressures up to 200 lbs. and temperatures to 400° F. Available from stock in all sizes from ½" to 2" I. D., in maximum lengths of 50 feet.

Contact Our Nearest Branch for Complete Information

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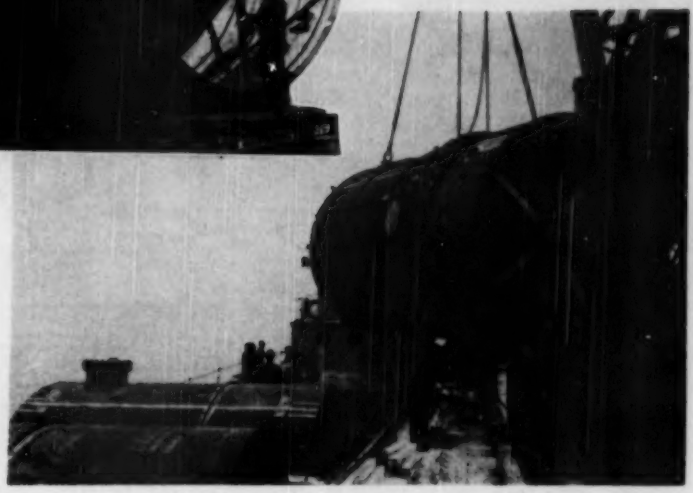

BUILDERS OF HEAVY EQUIPMENT

Sections of a synthetic-crude column are shown being loaded at one of the deep water piers of the company for shipment to Perth Amboy, New Jersey. This 90-foot high column was a part of recent production at Newport News that has included both a hot and a cold catalyst hopper, fractionator tower, reactor, and other items for the chemical and petroleum industries.

The wide range of large facilities in the 225-acre Newport News plant are particularly suited for the production of heavy equipment. Constant investigation keeps the plant abreast of the developments in manual and automatic welding methods. Modern radiographing instruments and large stress-relieving ovens are included in the plant facilities. Your inquiries are invited.

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Mich., and Toledo, Ohio.

Barrett holds a B.S. in chemistry and a Ph.D. from Cornell University.

Pritchard Firm Names New York District Manager

J. F. Pritchard & Company, of Kansas City, Mo., has opened a new district office in the Chrysler Building, New York, with A. B. McClelland, Jr., manager. The office will serve New York, Connecticut, New Jersey, and eastern Pennsylvania.

McClelland Jr.

McClelland was formerly employed nine years as sales engineer with The M. W. Kellogg Company and two years as sales manager for Project Engineering Company.

The Kansas City address of the Pritchard firm is 908 Grand Avenue.

Chief Engineer Heads Crosby Engineering Department

Birger H. Stolpestad, formerly assistant chief engineer of Crosby Steam Gage & Valve Company, Wrentham, Mass., has been promoted to chief engineer.

Stolpestad

As the new head of the engineering department he will be responsible for the company's safety and relief valves, pressure gages, and instruments.

Since obtaining his engineering preparation at Lowell Institute, Stolpestad has served Crosby in its service and engineering departments for 17 years.

Filtrol Building $3 Million Catalyst Plant in Utah

Filtrol Corporation has started construction of a $3 million plant in the outskirts of Salt Lake City, Utah. It is expected to be in operation by January. The 30-acre Salt Lake City site was chosen for the plant because of its nearness to clay mines, source of much of the company's raw materials.

Larger B&W Tubing Diameter

The Babcock & Wilcox Tube Company has topped a former maximum o.d. of 8⅝ inches by producing seamless hot-finished tubing in outside diameters up to 9⅝ inches and seamless cold-drawn tubing in outside diameters up to 8⅞ inches.

Joins Tube Turns Sales Staff

Landis O. Morris, Jr., has been assigned to the staff of Robert S. Tyler, Jr., manager of the Tulsa office of Tube Turns, Inc. Morris joined Tube Turns in 1949 and completed the company's sales training program.

General Controls Announces Four New Appointments

General Controls, Glendale, Calif., manufacturers of automatic pressure, temperature, level and flow controls, announces four new appointments to their staff of sales engineers. William Charles Stringfellow has been assigned to the Dallas branch office; Hamilton G. Sudler to New York; Ernest F. Bruegel to Philadelphia; and R. Roedder to Los Angeles.

Manages Moore LA Office

Donald R. A. Jones has been appointed manager of the branch office at Los Angeles of Moore Products Company. Jones has been a consulting engineer and industrial gas engineer with Southern California Gas Company. He is a registered mechanical engineer and received his engineering degree from the University of California at Berkeley.

Peabody Promotes Peterson

Peabody Engineering Corporation, New York, on July 26 elected Eric G. Peterson to the board of directors and appointed him vice president. In addition to his new duties he will continue as general manager of both the New York office and the Stamford plant of the Peabody Engineering Corporation.

Named by Republic Flow

Republic Flow Meters Company, Chicago, has appointed Ralph E. Holmes manager of Cincinnati district including central, western and southern Ohio and eastern Kentucky. Holmes is a mechani-

Is there a better bulk plant pump?
There is! THE NEW GILBARCO ROTO-PRIME!
Mechanical seal for trouble-free operation and freedom from leakage.
Minimum maintenance — motor oil lubricated.
Ball bearing equipped for long wear and efficient operation.
Capacity 50 to 450 g.p.m.
Gilbarco Roto-Prime Pumps are complete units — with base, electric motor, coupling, built-in check valve and mechanical seal.
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ROTO-PRIME
Self-Priming Centrifugal Pumps
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WEST SPRINGFIELD, MASS
TORONTO, CANADA

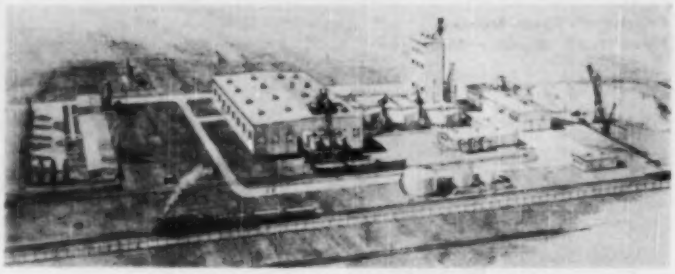
cal engineering graduate of the University of Michigan.

The Cincinnati office is located at 3197 Linwood Avenue, Cincinnati 8, Ohio.

GE Mechanical Engineer Heads Gas Turbine Sales

John R. Casey has been appointed manager of the newly established gas turbine sales division of General Electric Company's Apparatus Department's turbine divisions, with headquarters in Schenectady. Casey has been a turbine specialist in the Philadelphia office. He is a 1937 mechanical engineering graduate from Worcester Polytechnic Institute. Immediately following graduation, Casey joined GE's test course in Schenectady and has been with the company ever since.

New Filtrol Plant at Salt Lake City



Construction on Filtrol Corporation's new $3 million Salt Lake manufacturing plant, pictured above, is well under way. It should be in operation early in January.

The plant will be capable of making a full line of Filtrol products but is especially designed for the manufacture of an improved new catalyst for petroleum cracking, a "catalyst particularly suitable for the manufacture of high octane gasoline which will promote major economies in those refineries which generally require a catalyst of the synthetic type."

Manager of the Salt Lake plant will be Arthur D. Yates, who previously was superintendent of the Filtrol California plants. His technical adviser will be Warren Havell, also of Los Angeles.

Texas Plant to Produce Carter's Carlon Plastic Pipe

Carter Products Corporation has acquired a new plant in Corsicana, Texas, for the production of "Carlon" flexible plastic. Operations are to start this month. Its production will be utilized to supply plastic pipe demands in Texas and the Southwest.

Hammond Iron Works Opens Bristol Fabricating Plant

A 16-acre site of Hammond Iron Works' new and modern plant at Bristol, Pa., has main line railroad siding and near deep-water docks for marine transportation. The addition almost doubles the steel tank, stack, standpipe, breeching, alloy and steel, fabricating capacity of the firm whose main plant and offices are at Warren, Pa. A feature of the new plant's fabricating equipment is a planner with a 60-foot bed that can accommodate the largest size steel plates.

National Tube Executives

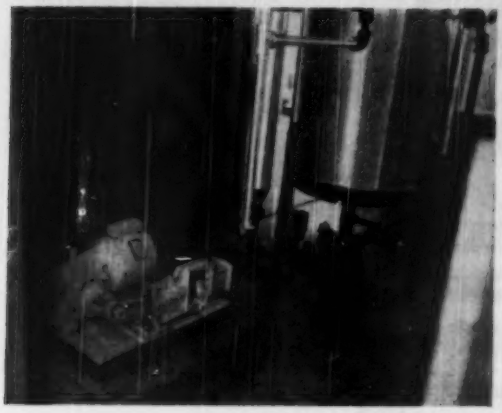
W. F. McConnor, formerly vice president in charge of sales, has been elected executive vice president of National Tube Company, United States Steel Corporation subsidiary. Henry J. Wallace, previously general manager of sales, succeeds McConnor.

Fourth New Store Opened By Vinson Supply at Snyder

Vinson Supply Company's new store located on Post Highway, Snyder, Texas, will carry a complete stock of crane valves and fittings, Nordstrom plug valves, Ladish welding fittings, Fisher control equipment, Chase antimonial Admiralty condenser tubes, and National Tube pipe and steel tubes.

Ray Barnett is manager of the new store which is under the direction of

MILTON Roy PUMPS



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Milton Roy engineers and furnishes controlled volume pumps and all necessary meters, actuating devices, and controls for automatic feed systems. For boiler water treatment, a complete "Packaged" system including pumps, instruments and tanks can be supplied ready for immediate installation.

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Layne constructs perhaps more big Well Water Systems than any other firm in the Nation. In addition to skill, Layne can offer the finest types of equipment, some of which they build for their exclusive use.

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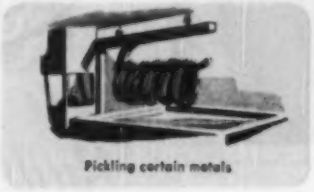

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Offices in Industrial Centers from Coast to Coast

Benny E. Keeling, West Texas district manager. Other stores are located in Tulsa, Dallas, and Odessa.

Blaw-Knox Appoints Baird Manager of Tulsa Office

Carl E. Baird has been appointed manager of the Tulsa office of Chemical Plants Division of the Blaw-Knox Company, Pittsburgh. This office serves the gas, natural gasoline, petroleum, and petrochemical industries with process equipment and complete plants.

Baird

Originally of Dallas, and with a background of business experience in the Southwest, Baird has been with the Blaw-Knox Company since 1946. He is a graduate of the University of Oklahoma and has had 10 years of engineering experience in the fields served by the Tulsa office.

Newport News Firm Appoints Hooper-Green Midwest Agent

The Newport News Shipbuilding and Dry Dock Company of Newport News, Va., has appointed Hooper-Green Company of Chicago and Indianapolis as its Mid-West sales representative. The Hooper-Green Company is headed by J. G. Green with offices at 407 South Dearborn Street, Chicago. A. J. Stone is district representative of the company

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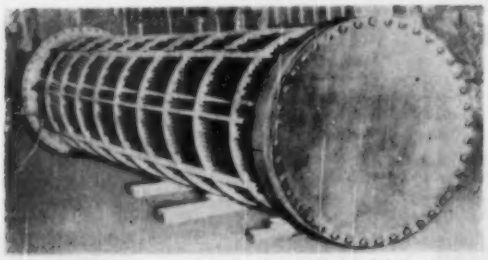

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Not only Monel, either. Any ductile metal inert to your process—any mesh up to 200 x 200 or 50 x 750—in any suitable weave—and cut to size and shape per your blueprints, ready to slip into place for a long, useful, low-cost life.

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in Indianapolis with offices at 2313 East Michigan Street. The Chicago concern will have the territory of Indiana, Illinois, southwestern Michigan, and a portion of Wisconsin and Iowa. They will represent the Newport News firm in the sale of all company products, with the exception of ship work.

American Meter Names Two District Sales Managers

Cloud

Gribbel

The American Meter Company has appointed Alexander B. Cloud district sales manager of the New York territory and John Gribbel, II, district sales manager for the Philadelphia sales territory.

Cloud was graduated from the U. S. Naval Academy in 1934 and joined American Meter Company in 1936. From then until 1942 he was located at the Metric Metal Works, Erie, Pa., where he was engaged in production, service, and sales work. After World War II Cloud rejoined American Meter in 1946 and served in New York.

Gribbel was graduated from the Sheffield Scientific School of Yale University in 1938. He has been employed by American Meter since 1947 as sales engineer in Philadelphia.

Christner Appointed Head of Eagle-Picher Insulation Unit

The Eagle-Picher Sales Company, Cincinnati, has appointed Glen J. Christner general manager of the Company's insulation operations.

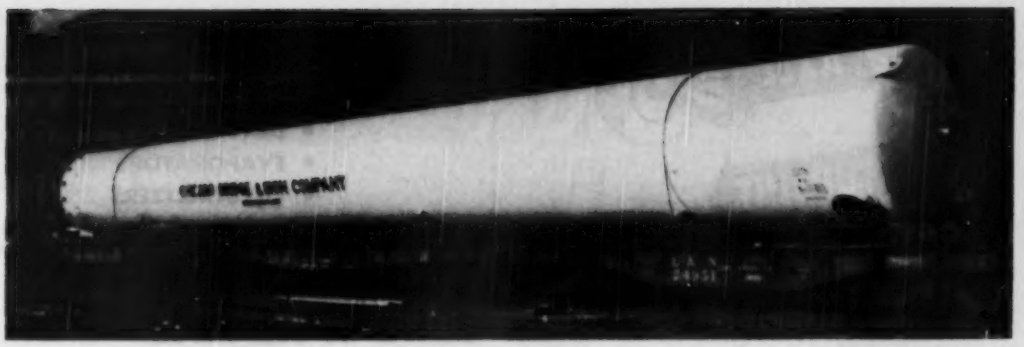
Christner

A graduate engineer of the Missouri School of Mines, Christner was for 9 years a sales engineer with Ingersoll-Rand. In 1932, he joined the Eagle-Picher organization as New York district manager of the insulation division.

Christner has been active in the National Mineral Wool Association, and for more than five years represented Eagle-Picher in ASTM sessions.

GE Apparatus Department Names Two to New Sales Posts

Francis E. Fairman of Pittsfield, Mass., has been appointed general sales manager of large apparatus divisions, and Arthur W. Bartling of Fort Wayne, Ind., has been named general sales manager of small apparatus divisions in



Corrosion of Process Equipment a Problem?

Read how alloy metals were used in this tower

The 10-ft. diam. by 110-ft. refinery tower in the above view is a crude fractionator for a refinery in Argentina. It will be subject to corrosive service at fairly high temperatures. The specifications required that it be lined as follows:

11-13 per cent chrome type 410 stainless steel lining for lower 60 ft. of shell, bottom head, and for nozzles in lower 79 ft. 6 in. of tower. (The carbon steel shell is not lined above the 60 ft. level.)

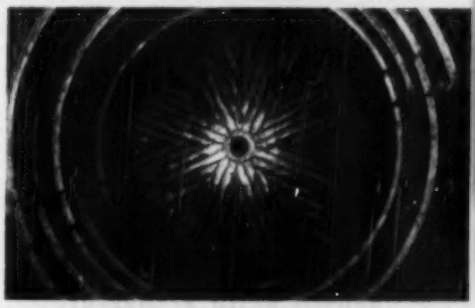
Monel lining for nozzles in the tower above the 79 ft. 6 in. level.

The lining strips in shell were attached by *automatic* welding using type 310 25-20 alloy rod. The strips in the bottom were attached by *hand* welding using 25-12 alloy rod. The heads were stress-relieved after forming and the entire vessel was random X-rayed.

It's evident that in the building of this tower—or any other—alloy linings must be attached correctly before the tower can function efficiently. Our long experience as fabricators of refinery equipment—and the fact that we are working with alloy metals constantly in our shops—are your assurance that we can install linings *properly*.

Refinery towers are only one of many kinds of steel plate structures we build for the petroleum industry. Others include flat-bottom storage tanks, Hortonspheres, Hortonspheroids, and Horton Floating Roofs. Write our nearest office for quotations or information when you need steel plate structures of any type.

This view shows two sections of the 10 ft. diam. by 110 ft. fractionating tower illustrated at the top of this page being fitted together at our Birmingham plant. Lining of the shell with strips of stainless steel has already been completed.



An inside view showing the bubble tray support rings and the stainless steel lining in the base of the tower. All of the stainless strips in the bottom were attached by hand welding.

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Birmingham 1	1548 North Fiftieth Street	Havana	402 Abreu Building	Salt Lake City 4	531 West 17th South Street
Boston 10	1030—201 Devonshire Street	Houston 2	2126 National Standard Building	San Francisco 4	1551—200 Bush Street
Chicago 4	2463 McCormick Building	Los Angeles 17	1534 General Petroleum Building	Seattle 1	1331 Henry Building
Cleveland 15	2234 Guildhall Building	New York 6	3302—165 Broadway Building	Tulsa 3	1626 Hunt Building

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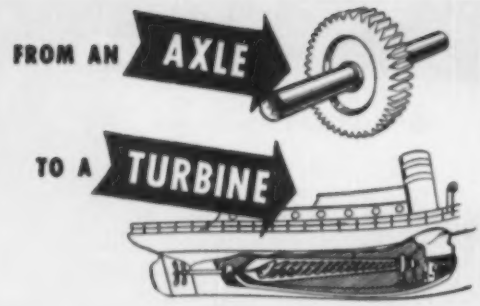

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The steam jet type of vacuum pump has continually gained in favor for high vacuum in industrial process work. The total absence of moving parts is a big advantage and means many years of service, with no maintenance cost. Available in single, two-, three-, four- and five-stage units for vacuum from a few inches up to a small fraction of 1 m.m. Hg. absolute.

Croll-Reynolds have been specializing on this type of equipment for over 30 years, and have made thousands of separate installations. Their engineers have extensive experience in applying it to numerous different processes, and are available for consultation without obligation. Literature is also available on request.

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Chill-Vactors Steam Jet Evactors Condensing Equipment

General Electric Company's Apparatus Department. Both sales positions are newly established.

Fairman, formerly manager of sales for the department's transformer and allied product divisions in Pittsfield, will be located at Schenectady, N. Y. Bartling, who was manager of sales for the department's fractional-horsepower motor divisions in Fort Wayne, will have headquarters at Lynn, Mass.

Barton Instrument Names Assistant Sales Manager

Alvah I. Thompson has been named assistant sales manager of Barton Instrument Corporation, Los Angeles. Thompson comes to Barton from Bristol Company, where he was project engineer in charge of aircraft development for nine years, and later sales engineer for four years. He is a director in the Southern California Meter Association, and chairman of the membership committee of the Instrument Society of America. He holds a degree in Electrical Engineering from Renssalaer Polytechnic Institute, 1933.

Thompson

Serving under Claude B. Nolte, Barton vice president and sales manager, Thompson, in addition to duties as assistant sales manager, will be in charge of sales in the Southern California territory.

General Sales Manager Named By Weston Electrical Firm

Philip Barnes has been appointed general sales manager of Weston Electrical Instrument Corporation. Barnes has been associated with Weston for 16 years. The announcement was made by Earl Mellen, president of the firm.

Barnes

Barnes during World War II served as a lieutenant in the U. S. Navy and following his return from active duty was appointed advertising manager. A resident of Union, N. J., he is chairman of the finance committee of the Union Board of Education, and is a member of the Advertising Club of New Jersey.

Weston offices are at 655 Frelinghuysen Avenue, Newark N. J.

Bailey Meter Firm Expands Engineering Staff by 16

Bailey Meter Company, manufacturer of industrial instruments and controls, has announced an expansion in its engineering staff as follows: C. R. Owen, to Denver; R. L. Hart, Kansas City, W. B. Martin, Philadelphia, V. W. Grant and J. T. Wilson, St. Paul, Minn. Serving in the engineering department of main office, Cleveland, Ohio, are F. D. Christhilf; G. N. McComb; V. W. Parsons; R. E. Pocock, and C. D. Shanks. With

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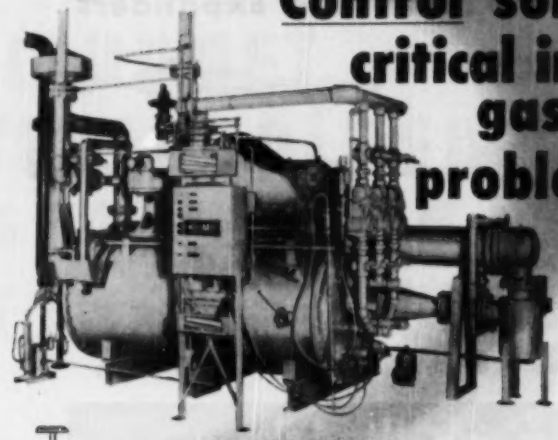

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No matter if you need inert gas for a critical or normal application—Kemp has the equipment you need! *One single knob* sets the air-gas mixture *accurately, permanently.* No matter what the demand, you get the same analysis inert gas from 1% to 100% of capacity. With Kemp there is *no need for tinkering!*

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Whether you need inerts for purging, fire protection, blanketing or a special application . . . specify Kemp. For technical information write for special bulletin. *To find out how much you can benefit:* tell us how you produce inerts now; we'll show you how Kemp can solve your problem! *Mail coupon today!*

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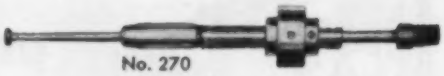
Ball Bearing-Adjustable Thrust Collar

No. 255



No. 270

• Loose collar remains stationary against tube end or sheet, reducing friction to a minimum. Prevents pulling of tube and will not mar sheet—specially ECONOMICAL for production work.

Expanders may be adapted for use with Automatic Torque Controlled Operating Units, for precision tube rolling.

For Complete Details . . . see Your Dealer, or Write Today

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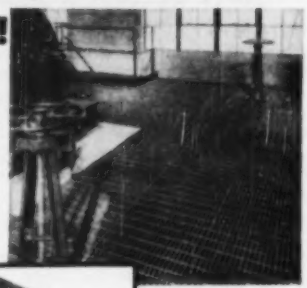
IT'S Blaw-Knox *Electroforged* Steel Grating! *Exceptionally strong*, electroforged into one solid piece. *Non-slip* twisted bar for safe, sure footing. Maximum open area. Self-cleaning, no sharp corners to clog. Easily installed and easily maintained. Adaptable to many uses, indoors and out, for every industry.



MEETS ALL REQUIREMENTS FOR
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Many other uses

Blaw-Knox Electroforged Stair Treads. Three types available: Rolled diamond checker plate nosing (illustrated), twisted cross-bar nosing, or abrasive nosing.

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of Blaw-Knox Company
2200 Farmers Bank Bldg., Pittsburgh 22, Pa.
Offices in Principal Cities

BLAW-KNOX ELECTROFORGED STEEL GRATING

research are R. Q. Brown, P. C. Hungerford; G. R. Markow, and R. F. Sutton. P. K. Bolyard and R. R. Walker are in sales.

MM&M Vice President Is Named Head of CAH Division

Chester H. Butterfield, vice president of Manning, Maxwell & Moore, Inc., has been named vice president in charge of the Consolidated-Ashcroft-Hancock Division, makers of valves, gauges and industrial instruments. Butterfield succeeds Hamilton Merrill, who was recently elected president of the company.

Butterfield

The division operates plants in Bridgeport and Stratford, Conn., Watertown, Mass., Jersey City, N. J., and Tulsa.

Butterfield has been with the company 33 years, the last eleven as vice president in charge of sales of the CAH Division.

Heads New Eastern Office For United Centrifugal Pumps

United Centrifugal Pumps, division of United Iron Works, has opened eastern headquarters at 225 Broadway, New York, with John Re as head. Re has been sales manager for the firm since 1947.

Re

Re entered the engineering department of United Iron Works in 1929 and became manager of the pump division in 1937.

Established in 1886, United Iron Works has for the past 25 years, specialized in the design and manufacture of centrifugal pumps for refinery, processing, and pipe line services.

Chase Brass & Copper Opens New Sales Office in Denver

Newest link in the coast-to-coast chain of warehouses and sales offices of Chase Brass & Copper Company, Incorporated, is the Denver sales office at 1421 Court Place. Charles J. McWhinnie, formerly a salesman for Chase in their San Francisco warehouse, is new manager at Denver. Assisting McWhinnie, as office manager, will be John M. Ceranich, a graduate of Kansas State University. McWhinnie was graduated from the U. S. Naval Academy at Annapolis and became associated with Chase in 1930.

Territory covered by the Denver office includes Colorado, Idaho, Montana, Wyoming, Utah and New Mexico, as well as the county of El Paso, Texas.

Quaker Oats Is Building Nebraska Furfural Plant

The Quaker Oats Company is constructing its third furfural chemical plant on a five-acre site in Omaha, Neb. Quaker has been producing the product

Announcing

MUNDET CUSTOM-MOLDED 85% MAGNESIA HEAT INSULATION

Mundet district offices are located in these cities:

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CHICAGO 16
2601 Cottage Grove Avenue

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427 West 4th Street

DALLAS 1
601 Second Ave.

DETROIT 21
14401 Prairie Street

HOUSTON 1
Commerce and Palmer Streets

INDIANAPOLIS
15 E. Washington St.

JACKSONVILLE 6, FLA.
800 E. Bay St.

KANSAS CITY 7, MO.
1428 St. Louis Avenue

LOS ANGELES
(Maywood)
6116 Walker Avenue

NEW ORLEANS 16
315-25 N. Front Street

PHILADELPHIA 39
856 N. 48th Street

ST. LOUIS 9
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In Canada:
Mundet Cork & Insulation, Ltd.
35 Booth Avenue, Toronto

This new Mundet plant is designed to provide you with superior heat insulation. Its facilities for the manufacture of Custom Molded 85% Magnesia Pipe Covering and Block Insulation are unequalled anywhere in the United States.

Operations are automatic and precision-controlled throughout manufacturing. Specially designed equipment and improved methods contribute to the production of heat insulation that serves more effectively, and at lower life-cost.

By using Mundet Custom Molded 85% Magnesia Insulation, you benefit from:

- *Greater Heat Saving Efficiency*
- *Controlled Uniformity*
- *Longer Life*
- *Custom Molded Precision Pipe Fit*
- *Attractive, Smooth Finish*

Descriptive folder, with simplified thickness standards, sent promptly on request. Write for it now. Mundet Cork Corporation, Insulation Division, 7309 Tonnelle Ave., North Bergen, N. J.

MUNDET

INSULATION FOR HIGH AND LOW TEMPERATURE

NEW Coating Treatment Gives You CLEAREST VISIBILITY over long period of time, with

JERGUSON GAGES

Another "First" for Jerguson that gives you a real plus value when you install Jerguson Gages

YOU can get Clearest Visibility over a long period of time with Jerguson Gages, for Jerguson is now coating all gage glasses with a new special compound that maintains improved visibility.

Jerguson gage glasses are far superior with this new treatment. They are far less subject to fouling through foreign matter adhering to the glass; and viscous liquids are largely prevented from hanging up, thus greatly improving the observation of the true liquid level. You get the advantage of another "First" in a long series of advancements by Jerguson.

Jerguson Gages are Easier to Service

All gaskets are treated with a special compound which *prevents adhesion to glass or metal* under high pressure or high temperature. Glass and gasket replacements are easily made without damaging seats through scraping.

Write for Data Units on Jerguson Gages and Valves.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY

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Representatives in Major Cities

Please Listed Under JERGUSON

since 1922. The new plant is expected to be in operation by the end of 1951. Other plants are located in Memphis, Tenn., and Cedar Rapids, Iowa.

Pacific Pumps Engineer Adds To Houston Sales Staff

John Wahlstrand has been named sales engineer of Pacific Pumps, Inc., with headquarters in Houston. Elmer J. Weis, vice president made the announcement.

Wahlstrand

Wahlstrand has lived in Houston since 1943 and is an associate member of the Houston Engineer's Club.

He is well known throughout the petroleum chemical and other industries in Texas, Louisiana, Mississippi, and Alabama.

Pacific Pumps manufactures centrifugal pumps.

Arthur Tesmen Appointed Sales Engineer for Tempil®

Tempil® Corporation has appointed Arthur B. Tesmen a sales engineer.

Previously, Tesmen was with North American Philips Company, Inc. in charge of sales-service, promotion and development of contact electrodes and other welding products. Prior to that he was with Crucible Steel Company of America as metallurgical engineer and with the Industrial Laboratory of the Philadelphia Navy Yard as a welding engineer.

Tesmen

Tesmen is a 1939 graduate of the University of Michigan (B. S. degree in metallurgical engineering) and did postgraduate work in metallurgy at Lehigh University. He has presented several technical papers before various chapters and regional meetings of the American Welding Society.

American Cyanamid Names Catalysts Sales Supervisor

The industrial chemicals division of American Cyanamid Company has appointed Gerald L. Glepsen supervisor of catalyst sales in the petroleum chemicals department. Glepsen joined the company in 1945 and has been a technical field representative covering the Gulf coast area for the petrochemicals department since 1948. Howard E. Nelms will continue as manager of this department.

B&W Tube Firm Opens New Alliance, Ohio, Plant

The Babcock & Wilcox Tube Company has added a new mill for the production of electric resistance welded tubing at the Alliance, Ohio, plant. As the third such unit for the welded tube division at Alliance, the plant will pro-

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That WEATHERCOAT—

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the insulation on your hot or cold vessels — for YEARS!

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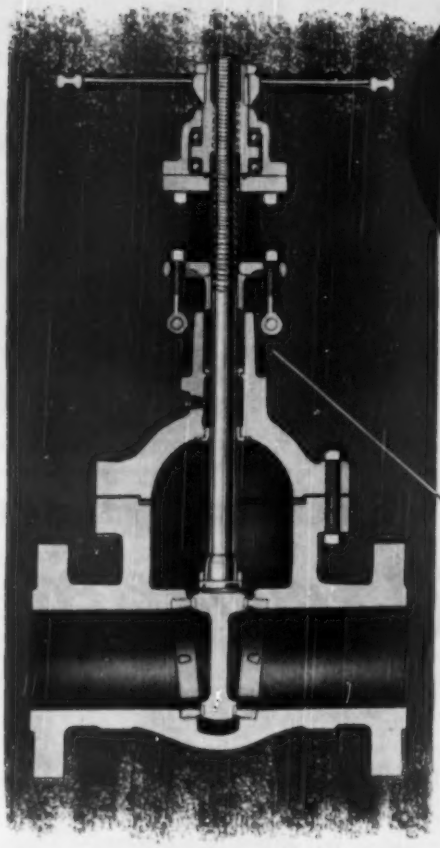
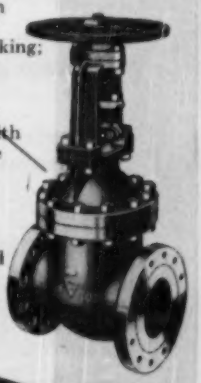
R·P&C
CAST STEEL VALVES



Note the **quality features** of this Gate Valve. They are typical of all valves in the R-P&C Cast Steel Line—gate, globe, angle and check valves in pressure classes 150 lb. through 1500 lb.

- **Ball Bearing Operating Nut** permits smooth operation with minimum effort.
- **One Piece Yoke with Cap** provides rigidity, perfect alignment and easy access to operating nut.
- **High Quality Packing** assures a tight stuffing box under all conditions—low stem friction—minimum servicing.
- **Gland and Follower with Ball Joint** applies uniform pressure on packing, prevents follower binding with stem.
- **Heat-treated Stainless Steel Stem** has high strength and corrosion resistance. Polished surface increases life of packing; T-head makes strong, self-aligning connection with wedge.
- **Solid I-Beam Wedge** is guided to proper seating by guide ribs cast integral with the body. Wedge seating surfaces are precision ground to fit perfectly with body seat rings.
- **Barrel-type Seat Rings** have heavy, uniform section; offer no points of high stress concentration; have broad seating surface, ground smooth for less wear—longer life. Port opening is full pipe diameter



***In addition** to the standard line, R-P&C offers cast steel gate and globe valves with Pressure Sealed Bonnet joint—especially adapted for high pressure, high temperature service. For information, get in touch with your nearest R-P&C District Office.*

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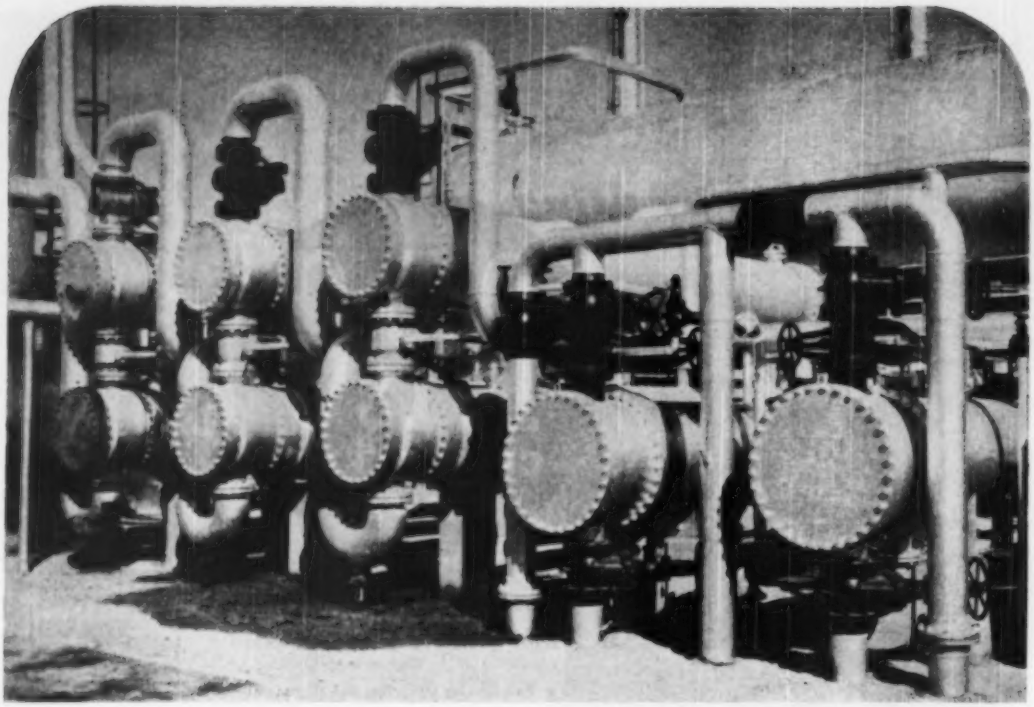
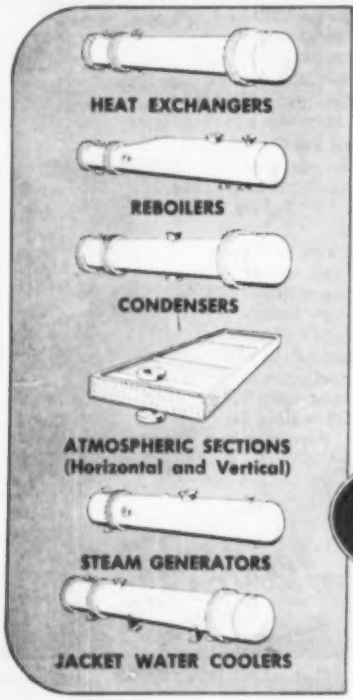


Make sure your Heat Exchangers are



"EFCO Engineered"

● Heat exchangers by EFCO specialists are carefully designed to meet *your* specific requirements. EFCO heat exchangers give you long, trouble-free operation plus the extra advantages of lasting tightness, optimum heat exchange, and minimum maintenance costs.

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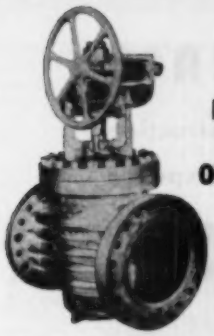
EFCO HEAT TRANSFER EQUIPMENT

WEDGEPLUG
ALL-PURPOSE
STEEL VALVES



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PRICED to compete with conventional plug-type valves. Interchangeable with American Standard Steel Wedge Gate Valves. Wrench-Operated; Direct Handwheel-Operated; Worm Gear-Operated; Sizes from 1" to 16". Write for our Catalog No. 600 and Price List. On request, we will be glad to quote on larger sizes above 16".

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duce tubing with outside diameters ½ inch and up and with wall thicknesses 20 gauge and heavier. It will supplement the other two mills and broaden the scope of sizes of ERW tubing that the company can produce. The new mill was placed in operation last month.

Bridgeport Brass Manager

E. D. (Pat) Casseday has been appointed Houston district sales manager, Bridgeport Brass Company succeeding George Chatneuff whose resignation has been announced.

Casseday

Casseday was recently with Bridgeport's Los Angeles Office. He has been connected with the copper and brass industry for the past 15 years, with experience in both the condenser and heat exchanger field, as well as in plumbing and heating.

In his new position at Houston, Casseday will be responsible for the sale of all Bridgeport products in southeastern Texas, company officials announced.

Flexitallic Names Agents And One New Distributor

The Flexitallic Gasket Company, Camden, N. J., has added three new agents and one new distributor to its field organization as follows:

The Metrol Company, Detroit, named agent for the lower peninsula of Michigan, including the Toledo area in Ohio.

Power Specialty Company, Houston, named distributor for eastern Texas and western Louisiana.

Illes Power Control Company, Cleveland, Ohio named agent for northern Ohio, east of the Toledo area.

Airdraulic Equipment Company, Buffalo, N. Y., named agent for western New York, including the Syracuse area.

American Cyanamid Plans East Chicago Catalyst Plant

A $3 million plant turning out 3000 ton of catalysts a year is being planned by American Cyanamid Company for East Chicago, Ill., for marketing in the Midwest and along the Atlantic seaboard. When in operation about the middle of 1951, the plant will have added 50 percent to the company's capacity. The concern now ranks among the largest producers of the material.

The new plant will largely produce microspheroidal cracking catalysts. The company also produces lubricating oil additives, drilling mud chemicals, dyes for gasolines and oils, stearated and similar products.

Three Division Managers Named

Peabody Engineering Corporation, New York, has appointed William Godley manager of contract sales, George E. Smith manager of the air heater division, and Edward R. Clark manager of the automatic oil burner division.

Graver Opens in Cincinnati

Graver Tank & Manufacturing Company, Inc., East Chicago, Ind., recently opened a district sales office in Cincinnati at 426 Transportation Building. Sales offices are already established in Chicago,

VICTOR alloy Studs and Bolts have met the exacting standards of the oil industry for more than 30 years. Victor is accustomed to meeting your requirements of quality, price and delivery. Try VICTOR next time you need any fastening.

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Only a Few Hours in Emergency
INCREASED CORROSION ALLOWANCE
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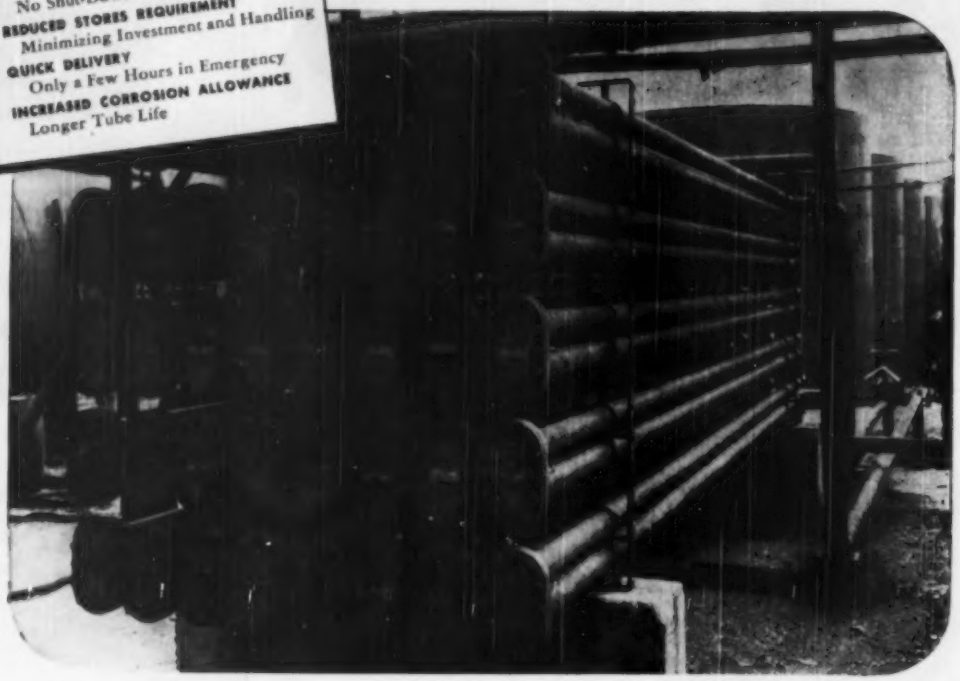
no obsolescence

Brown Fintube Sectional Construction Avoids Needless Waste and Expense



● Brown's interchangeability of parts, exacting design and precision manufacture has "licked" obsolescence.

The sections can be used in one exchanger after another — on different duties — on different products. A bank can even be broken up and the sections shipped to two or more plants, miles apart, assembled and reused. Sections not in use serve as "stores" for other sections on stream. They are *never obsoleted* by changes in duty or plant re-arrangements. You can use, and reuse them, until they are completely worn out.

For the utmost in *efficiency* and *economy*, install Brown's proven, welded fintube heat exchangers throughout your plant. Estimates and quotations furnished promptly. *Write for Bulletin No. 481.*

THE BROWN FINTUBE CO.
ELYRIA, OHIO

SECTIONAL HAIRPIN HEAT EXCHANGERS

New York, Philadelphia, Detroit, Houston, and Sand Springs, Okla.

John R. O'Connor, formerly in East Chicago, was made manager of the Cincinnati office. A mechanical engineering graduate of Purdue University, O'Connor joined Graver four years ago.

Union Malleable Agents Named

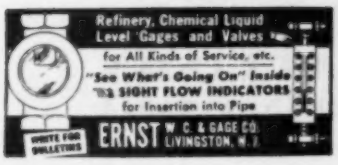
Union Malleable Manufacturing Company, Ashland, Ohio, has appointed as sales representative in the Rocky Mountain territory, Kent Engineering Company of Denver, Colo. Stuart S. Wills, Detroit, Mich., will represent the company in the Detroit and southeastern Michigan district.

Koppers Patent Head Named Foreign Manager

Irvin H. Jones, manager of the patent section, research department, Koppers Company, Inc., since 1944, has been named international development manager. He is responsible for the development of management-type contracts and participation of Koppers in foreign business ventures with foreign nationals in the chemical, tar products, wood preserving, coke and metal products fields. Foreign industrial design, engineering, and construction contracts and work still will be handled by the company's engineering and constructing division.

Dr. W. C. Ruckel, vice president, who has assisted in setting up the international development program since formation of an international sales section in February, will return to his position as manager of export sales for the engineering and construction division.

Dr. W. J. Monacelli, assistant manager of the patent section, research department, is acting manager of that section, succeeding Jones.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Experienced ENGINEER, familiar with Oil Refinery design and capable of estimating process equipment from flow diagrams. Give full information, experience record and salary expected.

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Integrated petroleum company has opening for chemical engineer to supervise refinery economic analysis group. Position requires minimum of two years' experience in preparation of cost and process studies, familiarity with catalytic cracking, and at least one year of training in accounting and business administration. Age limits 25-35. Address replies to Box 178-R, c/o Petroleum Refiner, Houston, Texas.

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Over four years experience with regulators, automatic valves, control devices, heat transfer units, flow meters, pumps, temperature, pressure and electrical instrumentation.
Excellent health, pleasant personality, age 25, single. Please contact Box 179-R, c/o Petroleum Refiner, Houston, Texas.

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CHIEF CHEMIST: Graduate chemical engineer minimum three to five years' refinery experience including control laboratory work and technical service in plant operations especially light ends and aviation gasoline blending.

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OCTANE TESTER: Thoroughly experienced routine methods and maintenance on aviation gasoline knock-testing engine.

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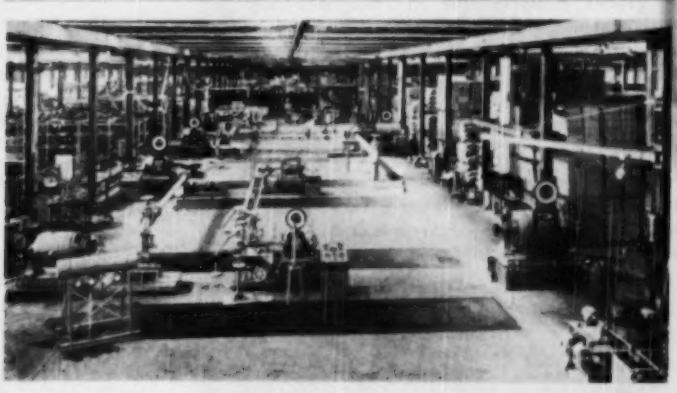
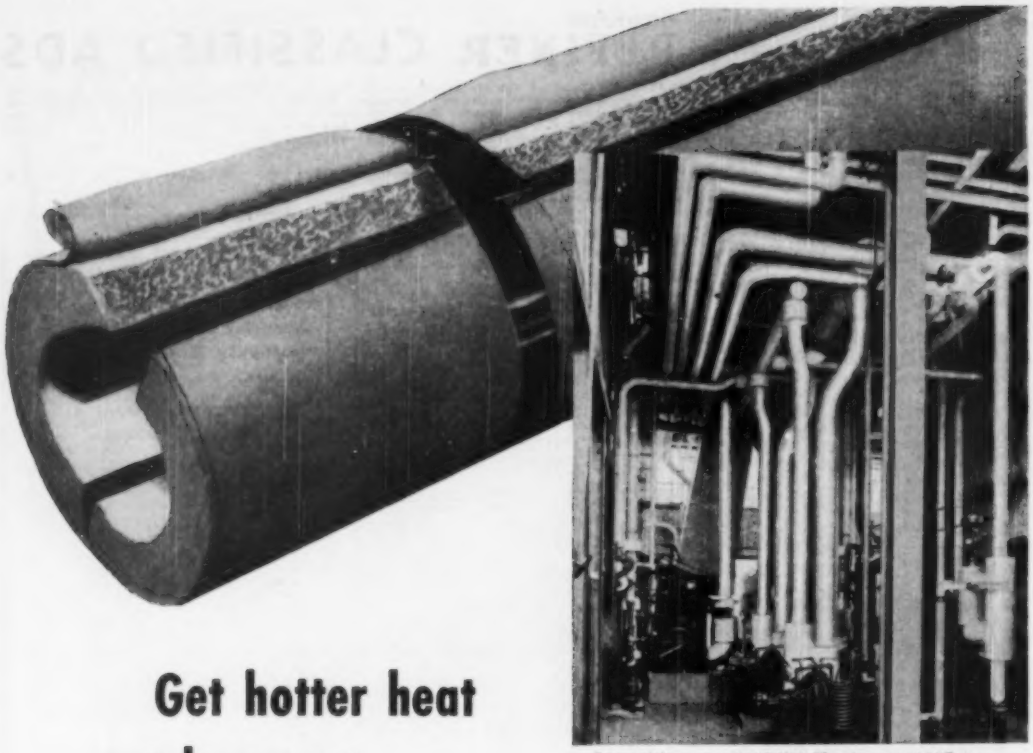


NEW PUMP TESTING LABORATORY—Above is general view showing eight test stations in the new quarter million dollar pump testing laboratory at the Indianapolis Works of the Peerless Pump Division of Food Machinery and Chemical Corporation. Pumps of all sizes and capacities from 5 to 86,000 gallons a minute and from 1 to 1000 h.p. can be accurately tested to ½ of 1 percent efficiency in this laboratory, which, company officials declare, is the biggest of its kind in the United States. The installation, finished last month, "establishes a completely new set of standards in pump testing procedure." It occupies more than 7000 square feet of floor area.



Steam piping, covered with K&M "Featherweight" 85% Magnesia, in Standard and 1½" thicknesses; canvas covered.

Get hotter heat at less cost with K&M "FEATHERWEIGHT"® insulation

Keep heating costs down—and heating efficiency up—with K&M "Featherweight" 85% Magnesia Insulation. 85% Magnesia is the most widely accepted insulating material in its field. And in K&M "Featherweight," basic carbonate of magnesia is combined with selected and specially processed asbestos fibers to produce a highly efficient insulation of extremely low thermal conductivity.

K&M "Featherweight" withstands temperatures up to 600° F. without loss of insulating value. And, though it's amazingly light in weight, it is strong and durable also. It can withstand vibration, a reasonable amount of compression, and its insulating properties are not affected by alternate wetting and drying. As it is entirely mineral by nature, it cannot burn.

"Featherweight" 85% Magnesia insulation is easy—and economical—to apply. It can be stored and handled without any special precautions. No special tools are needed to apply it: "Featherweight" is easily sawed and cut; can be fitted snugly to contours without breaking apart.

K&M "Featherweight" 85% Magnesia is furnished for all standard pipe sizes in sections and in sets of segments 3 feet long in the following thicknesses; Standard, 1½", 2", double standard (broken joint) and 3" (broken joint). Blocks and lagging are also available for irregular surfaces. Ask your K&M Distributor for complete information, or write us direct.

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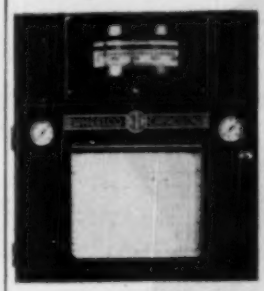

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. . . with the Wheelco Pneumatic Capacilog! *For safety*—where electric contactors or motors are a hazard—*for results*—where fixed position changes of fuel or medium are injurious to your product.

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Accidents are bound to happen . . . like dropping or banging a thermometer sufficiently hard to make readings inaccurate. This could result in costly production errors. To eliminate this possibility, Rochester now offers a new Dial Thermometer with screw adjustment permitting recalibration on the job! All you do is put the instrument in boiling water or other known temperature and reset indicator.

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Rochester solid stainless steel stem design gives you unfailing accuracy plus durability. Available in a wide range of designs.

No. 1725—3" dial No. 1750—2" dial No. 1825—6" dial
Stem lengths 2½", 3½", 6", 9", 12", 15", 18", 24"
One piece sockets—to fit all stem lengths

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Fahrenheit	Centigrade	Dual Scale
—50 to 120°F. 50 to 350°F.	—70 to 160°C.	—90 to 130°F.
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0 to 200°F. 150 to 750°F.	0 to 150°C.	
0 to 300°F. *200 to 1000°F.	0 to 300°C.	
30 to 240°F.	100 to 400°C.	

*Not recommended for continuous operation above 800°F.

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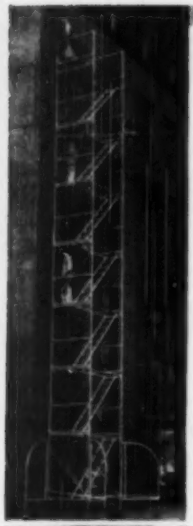
We require ..... dial thermometers with temperature range of ..... to .....°; ..... " dial; ..... " stem.
Please quote.

Name ..... Title .....
Company .....
Address .....
City ..... State .....



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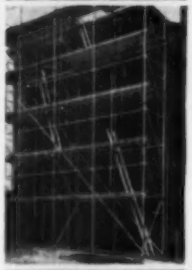

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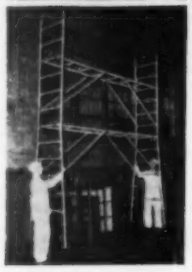

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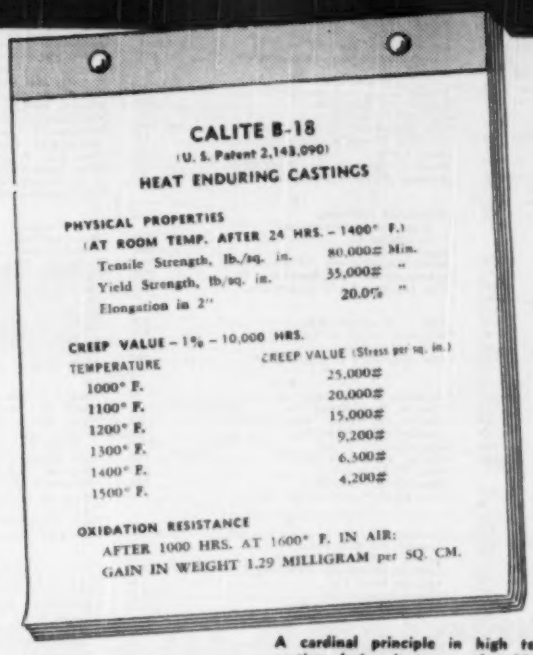
ALCOA FIRST IN ALUMINUM

CALITE B-18 ...a New

ADVANCED HEAT ENDURING ALLOY



CALITE B-18

(U. S. Patent 2,143,090)

HEAT ENDURING CASTINGS

PHYSICAL PROPERTIES

(AT ROOM TEMP. AFTER 24 HRS. – 1400° F.)

Tensile Strength, lb./sq. in.	80,000# Min.
Yield Strength, lb./sq. in.	35,000# "
Elongation in 2"	20.0% "

CREEP VALUE – 1% – 10,000 HRS.

TEMPERATURE	CREEP VALUE (Stress per sq. in.)
1000° F.	25,000#
1100° F.	20,000#
1200° F.	15,000#
1300° F.	9,200#
1400° F.	6,300#
1500° F.	4,200#

OXIDATION RESISTANCE

AFTER 1000 HRS. AT 1600° F. IN AIR:

GAIN IN WEIGHT 1.29 MILLIGRAM per SQ. CM.

A cardinal principle in high temperature casting design is to use the thinnest possible section in the strongest available alloy.

For service to maximum metal temperatures of 1650° F this Chrome-nickel-molybdenum alloy offers new possibilities for economical design. It is melted to the close chemical limits necessary to insure a desirable combination of high temperature strength and freedom from embrittlement in service.

Calite B-18 conforms to the requirements of Grade "F"—Manufacturer's Specification 10-38.

Copy of this specification will be mailed upon request.

THE CALORIZING COMPANY

HEAT ENDURING AND CORROSION RESISTING METALS

CALITE ALLOY CASTINGS — CALORIZED STEEL

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even at concentrations above 15,000 parts per million!

You may find it hard to believe that good quality steam can be produced with boiler concentrations in excess of 15,000 parts per million. But look at this analysis of samples from a Southwestern refinery power plant.

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NEW YORK 17, N. Y.

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LABORATORY AND PLANT
4027 NORTH AMERICAN STREET

GENERAL OFFICES
400 MADISON AVENUE

CHICAGO 11, ILL.
WRIGLEY BUILDING

Date April 27, 1950

CHEMICAL ANALYSIS

Results expressed in [illegible] parts per million

SAMPLE MARKED	Boiler Make-Up (Raw)	Conden-sate	Boiler Feed	Boiler #5	Boiler #8
ANALYSIS NUMBER 500410					
Total Dissolved Solids	1002	6	612	15980	13992
Suspended Solids	Trace	0	8	1052	332
Carbonate Hardness ($CaCO_3$)					
Non Carbonate Hardness ($CaCO_3$)					
Total Hardness ($CaCO_3$)	36	0	20	0	0
Calcium ($CaCO_3$)	24				
Magnesium ($CaCO_3$)	12				
Sodium (Na)					
Silica (SiO_2)	13		7	88	88
"P" Alkalinity ($CaCO_3$)	0	0	0	1520	1410
"M" Alkalinity ($CaCO_3$)	168	4	112	2160	1910
"OH" Alkalinity ($CaCO_3$)			0	1030	1020
Chlorides (Cl)	420	0	256	5900	5210
Sulfate (SO_4)	27	0	12	224	212
Phosphate (PO_4)		0	0	60	55
Nitrate (NO_3)					

Caustic embrittlement observations have been made at this plant for more than ten years with continual negative findings.

HOW? **with CONCENTROL**

Bird-Archer's new Concentrol was specially developed to eliminate foaming and boiler water carryover due to high alkalinity, dissolved solids, suspended solids or any combination of them.

Concentrol works by effecting a rapid change in surface tension of steam bubbles which permits coalescence of small steam bubbles into bubbles of larger size. This results in the formation of unstable bubble films which break readily upon reaching the steam disengaging surface of the boiler water, thus eliminating foam build-up and subsequent boiler water carryover.

Concentrol is available in several different formulations, some of which contain selected tannins, which condition boiler water sludge and suspended matter, maintaining them in a highly fluid, non-adherent form. Concentrol may be safely fed through feedlines and when fed continuously will help inhibit feedline deposits.

For full details on economical, efficient Concentrol, send for Data Sheet. For recommendations on your specific problem, consult your nearest Bird-Archer representative. Or, write direct to Bird-Archer outlining the details of your boiler operation.

BIRD-ARCHER
WATER TREATMENT

THE BIRD-ARCHER COMPANY, 400 MADISON AVE., NEW YORK 17, N. Y.

PHILADELPHIA • CHICAGO

IN CANADA: The Bird-Archer Co., Limited, 503 McGill Building, Montreal, Canada

IN MEXICO: Calderas y Accesorios, S. A., Amsterdam 291, Mexico, D. F.

BA-159.

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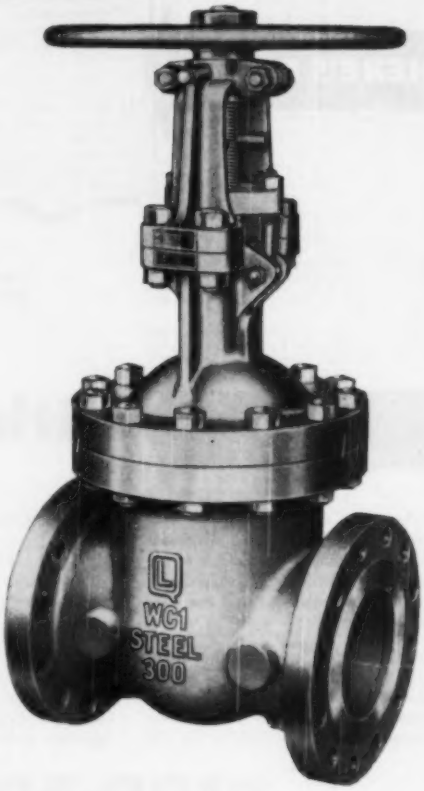

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LUNKENHEIMER

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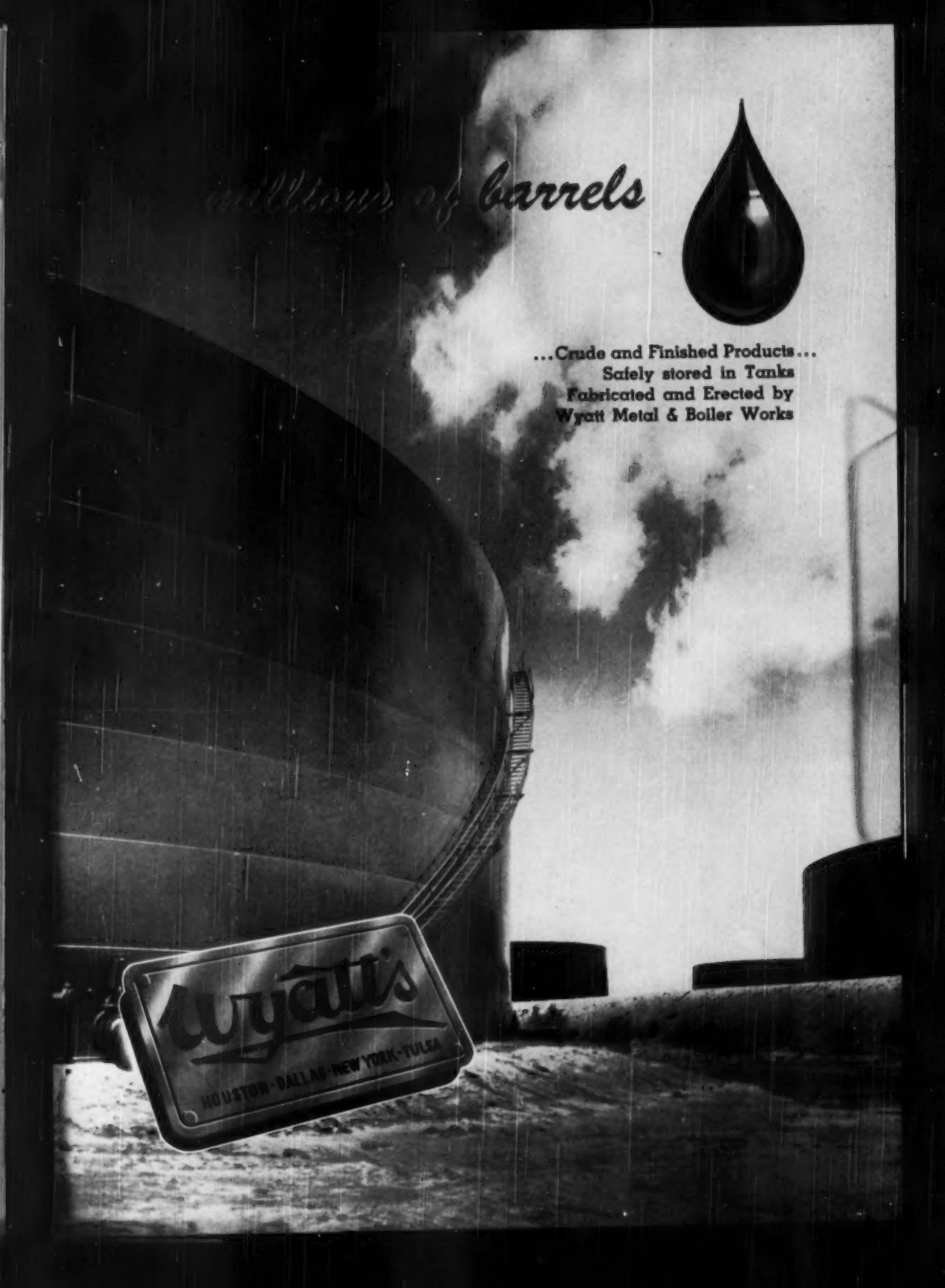
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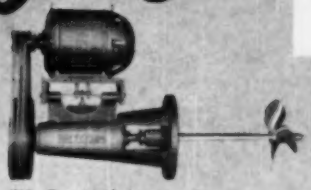

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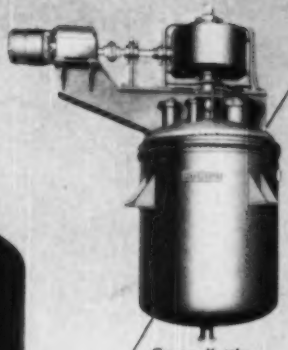

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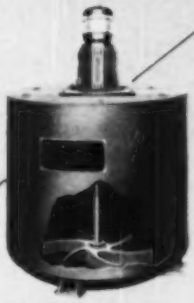

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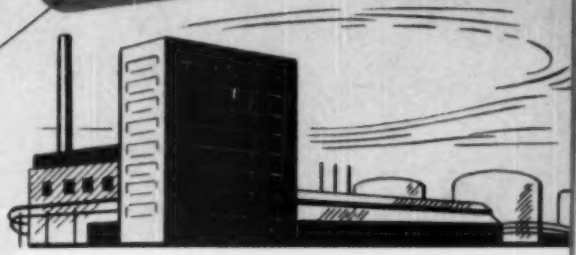

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President

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